SERIES MS700

MONITOR OSCILLOSCOPES

TECHNICAL MANUAL

V U – DATA CORPORATION

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SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. The Model MS701A is the Rack Chassis and Power Supply used for the Series MS200 Series oscilloscope modules. The Model MS701 consists of an all steel chassis with machined metal board guides to accept the oscilloscope modules and a power supply section that provides the necessary supply voltages for both oscilloscope modules. The board guides ensure a positive mating of the gold plated Elco connectors with the master receptacles. The connectors utilized on the master panel are also channelled to guide each connector into its correct position just prior to contact. This method of construction allows for removal and replacement of a module without having to pull the Model MS701 out of the system cabinet.

1-3. The Model MS701A accepts three different type oscilloscope modules. The Model numbers with a description are:

MS700A	Standard Monitor Oscilloscope (includes 1 each MS701A with 2 each Model MS240A Oscilloscope Modules.
MS700A(B)	Biomedical Monitor Oscilloscope (includes 1 each MS701A with 2 each Model MS250A Oscilloscope Modules.
MS700A(R)	Recorder Monitor Oscilloscope (includes 1 each MS701A with 2 each MS210A Monitor Oscilloscopes.

1-4. This manual will provide the operation and maintenance information required by the equipment operator or service technician to service the Model MS701A Rack Chassis/Power supply only. A supplement manual will provide the information required for the specific module used in each of the three different Models. The manual does not include information pertaining to special equipment applications nor does it include instructions for accomplishing repairs of the type performed at the factory.

1-5. The manual is divided into eight sections. Section I provides general information regarding the purpose of the equipment, its physical arrangement, and its pertinent specifications. Section II contains information on installation and unpacking. Section III contains instructions for operating the equipment. Section IV describes the theory of operation of the equipment circuits and mechanisms. Section V provides test, alignment, and maintenance procedures. Section VI contains a complete parts list. Section VII contains complete circuit drawings. Section VIII provides a list of recommended spares.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High voltages, which could be lethal are accessible and extreme caution should be taken. Only screwdrives with insulated shafts should be used for setting the adjustments. The top cover should be removed only for the duration of time required to make the alignments. The power should be off while the cover is being removed or installed.

1-6. The MS701 provides selection of 16 different channels of information, and display of any two of these channels simultaneously.

1-7. The power supply voltages required for operation of the oscilloscope modules are developed in the power supply assembly using a single etched board located between the modules. The power supply voltages are called from the power supply board to the connectors on the master panel for application to the modules. The power switch and indicator are located on the front panel.

1-8. Seven signal inputs for Channel A (Rec or reproduce input), seven signal inputs for Channel B (REP or reproduce input), and seven external trigger inputs for Channel A are located on the rear panel in addition to the input power cable and fuse. Signals from these inputs are cabled TO THE FRONT PANEL. The selected signals are cabled to the connectors located on the master panel for application to the oscilloscope modules.

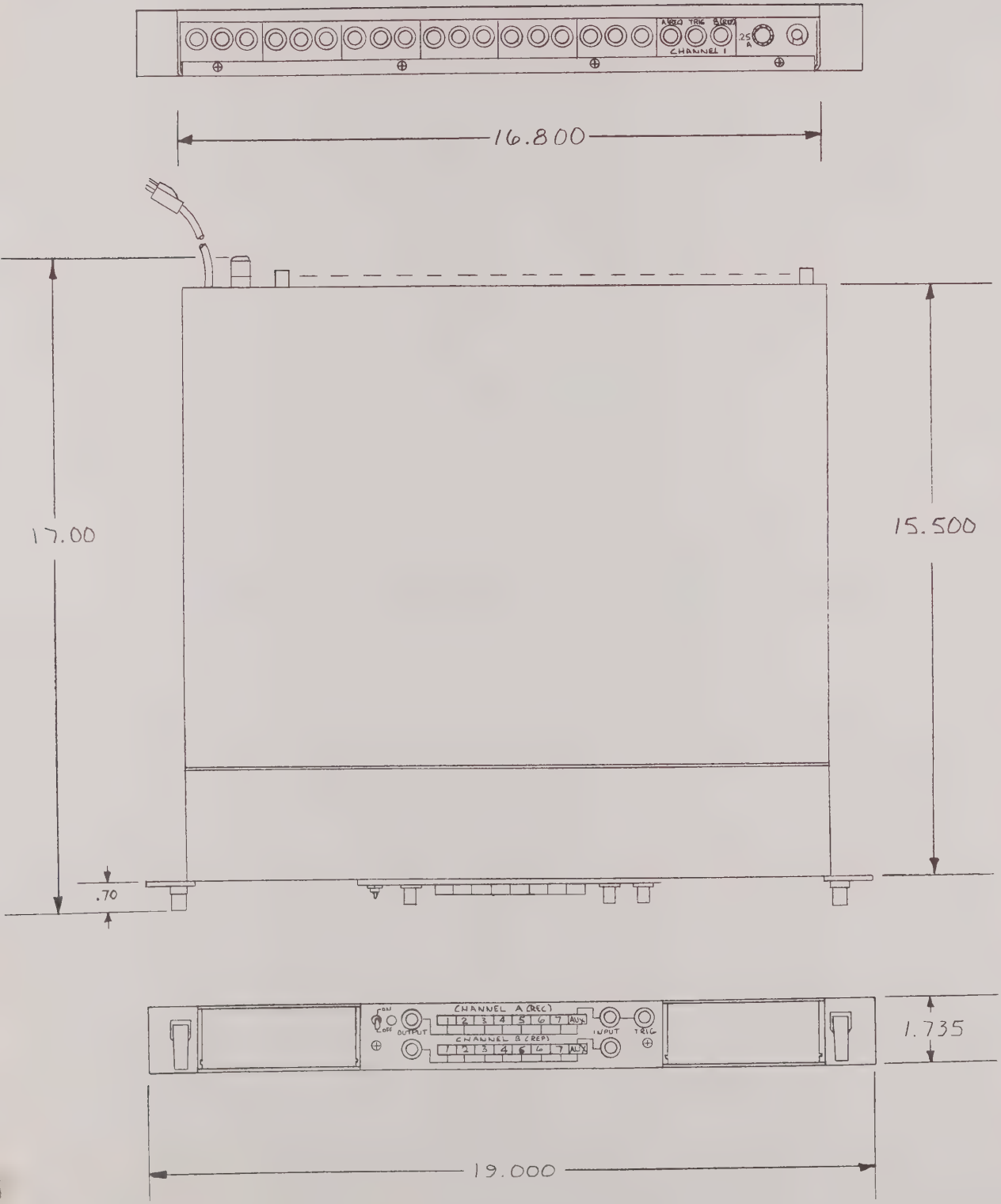


Figure 1-1. Dimensional Drawing

1-9. SPECIFICATIONS

REFER TO OSCILLOSCOPE MODULE BEING USED FOR SPECIFICATIONS

SECTION II

INSTALLATION

2-1. INSPECTION UPON RECEIPT

2-2. The Series MS701 is aligned, calibrated, and tested under severe environmental conditions prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure that the instrument has suffered no damage in shipment.

a. A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier. If extensive damage of the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be kept for inspection.

b. A visual inspection for damage should be accomplished upon removing the instrument from the shipping container. Remove the top cover and check for loose or broken components. Check to see that the printed circuit boards are mated with their connectors and are well seated. Remove each module and check for loose or broken components.

SECTION III

OPERATION

3-1. OPERATING CONTROLS

3-2. All of the controls necessary for the operation of the Series MS700 Monitor Oscilloscope are located in such a way to facilitate the ease in operation required by the operator.

3-3. The Series MS700 Monitor Oscilloscope is comprised of (1) a Power Supply Rack Chassis, Model MS701 which contains the power supply, master panel, input connectors, and switching matrix, and (2) one or two plug in module oscilloscopes. Table 3-1 describes the function and location of operating controls. The primary controls are located on the rack chassis front panel.

CONTROL	POSITION	FUNCTION	LOCATION
POWER	OFF	AC power removed from instrument	Front panel of MS701
	ON	AC power applied to instrument	
CHANNEL A SELECTOR	1	Ch. 1A Input connected to A Input of modules.	Front panel of MS701
	2	Ch. 2A Input connected to A Input of modules.	
	3	Ch. 3A Input connected to A Input of modules.	
	4	Ch. 4A Input connected to A Input of modules.	
	5	Ch. 5A Input connected to A Input of modules.	
	6	Ch. 6A Input connected to A Input of modules.	
	7	Ch. 7A Input connected to A Input of modules.	
	AUX	Front panel AUX Input A connected to A Input of modules.	
CHANNEL B SELECTOR	1	Ch. 1B Input connected to B Input of modules.	Front panel of MS701
	2	Ch. 2B Input connected to B Input of modules.	
	3	Ch. 3B Input connected to B Input of modules.	
	4	Ch. 4B Input connected to B Input of modules.	
	5	Ch. 5B Input connected to B Input of modules.	
	6	Ch. 6B Input connected to B Input of modules.	
	7	Ch. 7B Input connected to B Input of modules.	
	AUX	Front panel AUX Input B connected to B Input of modules.	

Table 3-1. Function and Location of Operating Controls

3-4. INDICATORS

3-5. The power indicator is located on the front panel of the MS701. This light indicates when the power is applied to the unit.

3-6. CONNECTORS

3-7. The MS700 has two groups of connectors, the BNC connectors which supply the inputs and outputs to and from the MS701 rack chassis and the internal connectors which furnish the signals and power from the MS701 to the Oscilloscope Modules.

a. The front and rear panels of the MS701. The A(Rec) and Trigger inputs 1 through 7 are cabled to the Channel A (Rec) switch assembly 7015002 for front panel selection. The B (Rep) inputs 1 through 7 are cabled to the Channel B (Rep) switch assembly 7015003 for front panel selection. The Aux inputs located on the front panel of the MS701 are cabled to their respective switch assemblies in the same manner as the rear panel inputs. The Channel A and Channel B outputs located on the front of the MS701 are the respective signals selected by the 7015002 and 7015003 switch assemblies, and are the same signals that are being applied to the oscilloscope modules.

b. The two identical internal connectors which supply the signals and power to the oscilloscope modules are located on the master panel and mate with the connectors located on the rear of each module. Nine different supply voltages (+190v, +37v, −5.5v, +5.5v, −1970v, 6.3VAC, −2045v, −2000v, and 0V) are cabled from the power supply assembly located to the rear of the front panel switches. The three input signals (A In, B In, and Trig In) are the signals that are selected from the BNC inputs by the front panel switches. The two internal connectors are wired in parallel. The pin connections for these connectors are shown in Figure 3-1.

3-8. Pre-Operational Adjustments

3-9. The Series MS700 Monitor Oscilloscope has been pre-adjusted at the factory and therefore should require no special adjustments prior to operation.

WARNING

The voltages used in the Model MS701 Power Supply/Rack Chassis are lethal. Precautions should be used when working on the instruments when the top cover is removed.

3-10. Before applying power to the Series MS700, the unpacking procedure, (reference paragraph 2-1) must be accomplished to ensure the instrument has suffered no damage in shipping or handling.

3-11. Prior to performing any electrical tests, the modules (2 each in the MS700) should be positioned as follows:

CONTROL	POSITION
Vertical	Centered
Horizontal	Centered
Trace Angle	Centered
Focus	Centered
Intensity	CW
Trigger	+
A-B Switch	Gnd

AC/DC Switch	DC
V/Div	.05
msec/Div	10msec
X10 Vernier	CAL

3-12. Preliminary Operation

3-13. With the controls as shown in Paragraph 3-11, insert the power cord into a 115VAC ±10% 50 to 400 Hz power source.

NOTE

If the instrument is to be operated on 230VAC, the jumper wires, located on the power supply board must be changed. For 115v operation two jumpers are required 1 from A to C and 1 from B to D. For 230v operation the 115v jumper must be removed and installed from C to B.

3-14. Switch the power switch to on and the power indicator should light.

3-15. Control Verification

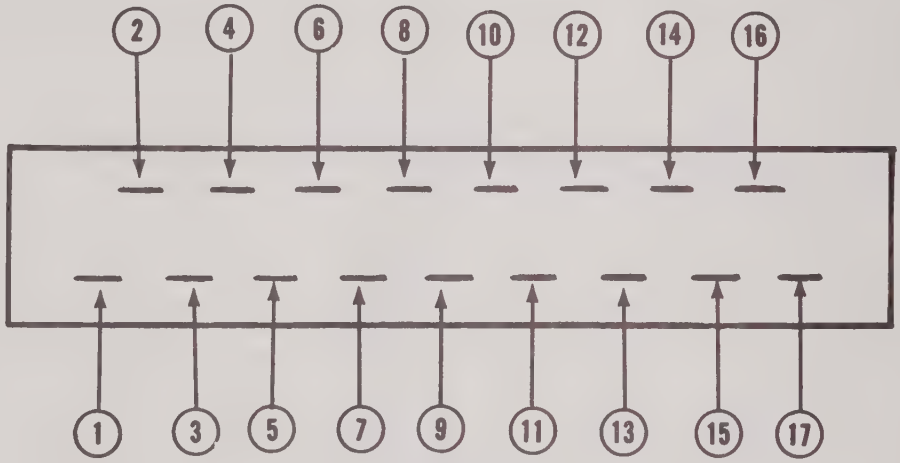
3-16. If the unit is functioning properly, a slow moving trace should appear on the face of each CRT.

CAUTION

Do not leave the intensity control in the maximum clockwise direction with a continuous display for long periods of time as phosphor burns on the CRT will occur.

3-17. Post Operational Procedures

3-18. The Series MS700 requires no preventive procedures when the instrument is not in use other than good housekeeping practices of cleanliness. Should the instrument be defective or fail to meet the requirements of Table 3-2., the maintenance section should be consulted for possible correction measures. If information is desired from one of our Field Representatives or Vu-data Corporation, consult the warranty section of this manual.



FRONT VIEW

1	BLANK	10	0VDC (Circuit Common)
2	-2000VDC	11	+40VDC
3	– 2045VDC	12	+190VDC
4	6.3AC	13	REP INPUT LOW
5	- 1970VDC	14	REP INPUT HIGH
6	BLANK	15	REC INPUT LOW
7	EXTERNAL TRIGGER	16	REC INPUT HIGH
8	+5.5VDC	17	LIGHT RETURN
9	– 5.5VDC		

Figure 3-1. Connector Pin Locations

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

4-2. A single printed circuit assembly make up the instruments power supply section. The assembly is located in the Rack Chassis/Power Supply and provides the power required for one or two oscilloscopes modules. The power supply voltages, along with the input signals and external trigger are supplied to each of the two oscilloscope modules by the two connectors located on the master panel assembly.

4-3. POWER SUPPLY

4-4. The power supply portion of the MS701 is contained on one printed circuit assembly located to the rear of the front panel switching matrix. The power supply contains all the components required for developing the low and high voltages required for the oscilloscope modules. The outputs from the power supply section are "hard-wired" to the connectors which accept the oscilloscope modules.

4-5. The 3 wire power cord is passed through a strain relief located on the rear panel of the MS701. The high side is connected to the fuse and the low side is connected to the power supply assembly. The ground wire is connected to the chassis at the master panel. The high side passes through the fuse and is connected to the front panel power switch. The arm of the switch is returned to the power supply assembly where it connects to a series of jumpers which allow the instrument to operate on either 115VAC or 230VAC. For 115VAC operation, the two transformer primaries are connected in parallel by jumpering from A to C and B to D on the power supply circuit board. For 230VAC operation, the two transformer primaries are connected in series by using one jumper from C to B. The 115VAC jumper must be removed before operating at 230VAC.

NOTE

All instruments shipped will be wired for 115VAC operation unless marked otherwise. Never operate an instrument at 230 VAC without making sure the jumper is properly located as damage to the instrument may result from improper application of voltage.

4-6. The transformer secondaries are wired to the power supply board near their respective regulators.

4-7. LOW VOLTAGE SECTION

4-8. The low voltage section contains all of the rectifier and regulator circuitry to provide a regulated 190, 37, 5.5 and −5.5VDC voltage. Each supply is current limited to protect the supply in case of a short circuit on the output.

4-9. The 190 volt AC to DC converter consists of rectifier bridge CR4 and filter capacitor C7. The regulation circuit consists of transistor Q4, resistor R6, diodes CR13 and CR14. Zener diode CR13 and CR14 set the level of the voltage at the base of transistor Q4 and the regulated output is on transistor Q4's emitter. Resistor R6 supplies current for the Zener and base current for transistor Q4. Resistor R15, diode CR11 and CR12 are current limiting components. When the voltage across resistor R15 increases due to excessive load diodes, CR11 and CR12 conduct through resistor R6 thus decreasing the voltage across the zeners and limit the output current. Capacitor C13 is an output filter capacitor to decrease the AC output and ripple.

4-9. The AC to DC converter of the 37 volt supply consists of rectifier bridge CR1, Filter capacitor C5, and resistor R1. Integrated circuit IC1 is a C voltage regulator which operates in conjunction with the series pass transistor Q1 to provide the regulation of the 37VDC. Resistors R9, R21 and potentiometer R20 establishes the bias level at the sensing input of the voltage regulator. Resistor

R11 is the current sensing resistor and capacitor C10 is a compensating capacitor for the IC regulator. Capacitor C16 is the output filter capacitor for the 37VDC regulated output.

4-10. The AC to DC converter for the 5.5VDC supply consists of bridge rectifier CR2 and filter capacitor C1. Integrated circuit IC2 is a voltage regulator which operates in conjunction with the series pass transistor Q2 to provide regulation. Resistors R22, R24 and potentiometer R23 set the bias level at the sensing input of the regulator. Resistor R12 is the current sensing resistor and C11 is the frequency compensating capacitor for the IC regulator. Capacitor C17 is the output filter capacitor for the 5.5VDC supply.

4-11. The AC to DC converter for the −5.5VDC supply consists of rectifier bridge CR3 and filter capacitor C2 and C6. IC3 is an integrated circuit regulator which operates in conjunction with pass transistor Q3 providing the regulation for the supply. Resistors R25, R27 and potentiometer R26 establish the DC bias level for the sensing input to the regulator. Resistors R13 and R14 are the current sensing resistors and capacitor C12 is the frequency compensating capacitor for the IC regulator. Capacitor C18 is the output filter capacitor for the −5.5VDC supply. The unregulated output from the AC to DC converter supplies the current for the light emitting diode located on the front panel, for power ON/OFF indication. Resistor R29 sets the current level through the diode.

4-12. HIGH VOLTAGE SECTION

4-13. The high voltage section consists of a 2000 volt and 45VDC regulators. The AC to DC converter for the 2000VDC supply consists of rectifiers CR5 and CR6 in conjunction with filter capacitors C3 and C4. The converter is connected in a voltage coubler configuration. Zener diode CR8 provides a plus DC reference voltage for the 2000VDC regulator. Resistor R7 provides a DC current for diode CR8. Resistors R3 and R4 are a divider network to sample the 2000VDC supply. The sampled voltage at the junction of R3 and R4 is fed into the error amplifier IC4. This voltage is compared to zero volts which is connected to the other input of the error amplifier through resistor R8. The difference or error signal is amplified by the integrated circuit amplifier IC4 and connected to the series regulating transistor Q6. Transistor Q5 is used to increase the effective breakdown voltage of the series regulator. Resistors R10 and R17 set the bias and provide bias current to transistor Q5. Resistor R16 limits the current that can be drawn from the supply. Diodes CR9, 10, 15, 16 and 17 are all protection diodes which limit the voltage swing at the input and output of the error amplifier. Capacitor C14 is the output filter capacitor for the supply. The output of the supply is connected to zero volts making the output a minus 2000VDC.

4-14. The AC to DC converter for the 45VDC supply consists of bridge rectifier CR7 and filter capacitor C8 and resistor R5. The regulator circuit consists of resistor R9, diode CR20 and transistor Q7. Zener diode CR20 sets the operating voltage at the base of transistor Q7 whose emitter is the regulated output. Resistor R9 provides current for diode CR20 and base current for transistor Q7. Resistor R18 and diodes CR18 and CR19 provide current limiting for the supply. When the voltage across resistor R18 becomes too large due to excessive load, the divider will conduct through resistor R9. This decreases the voltage at the base of transistor Q7 and therefore the emitter which limits the current. Capacitor C15 is the output filter capacitor.

The plus output from the supply is connected through a jumper to the minus 2000VDC supply which floats the entire supply at minus 2000VDC and provides a minus 2045VDC output. For ease in trouble shooting, the jumper may be removed and supply connected to zero volts to allow low level signal tracing. To operate in this manner, the jumper that connects the line from the minus 2000VDC filter capacitor C4 to the minus 2000VDC must be removed.

4-15. Zener diode CR21 provides the additional voltage output of minus 1970VDC. This voltage is zenered down from the minus 2000 volt. One side of the 6.3VAC for the CRT filaments is connected to the −1970 which floats the filament winding at the 1970 level.

SECTION V

MAINTENANCE

5-1. GENERAL

5-2. The following procedure provides the information necessary for technical personnel to align and calibrate the Series MS701 Rack Chassis/Power Supply. This alignment should be accomplished at regular periodic intervals to ensure the proper operation of the instrument.

5-3. The Series MS700 Monitor oscilloscope consists of the power supply/rack chassis, Model MS701 and the oscilloscope modules. The alignment and calibration for the MS701 are covered in this procedure. The calibration of the power supply should always be accomplished prior to the modules.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High voltages, which could be lethal are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The top cover should be removed only for the duration of time required to make the alignments. The power should be off while the cover is being removed or installed.

5-4. Test Equipment Required

5-5. The following test equipment is required to align and calibrate the instrument. The model number and manufacturer may be substituted if the specifications of the substituted units are equal to or better than the listed equipment.

1.	Sine wave generator	HP Model 651B
2.	Square wave generator	HP Model 211B
3.	Frequency Counter	HP Model 5321B
4.	Oscilloscope	Vu-data PS910A
5.	DC Voltmeter	Honeywell Model 500

5-6. MODEL MS701

5-7. After a 30 minute warmup, turn off the power and remove one of the oscilloscope modules. The voltages from the power supplies can be measured on the exposed connector, (see Figure 3-1). If the voltages need aligning, remove the top cover. The adjustments are located on the underside of the power supply assembly. The removal of two screws on the power supply board nearest the front panel will allow the assembly to be raised exposing the components and the adjustments.

5-8. Voltage Adjustments

1. Turn the power on.
2. 37VDC----
   Using the DC Voltmeter, measure between Pin 11 (high) and Pin 10 (low). The voltage should be 37.0 volts with 5%.
3. If alignment is required adjust potentiometer R20 located nearest the rear of the instrument.
4. –5.5VDC----
   Using the DC Voltmeter, measure the voltage between Pin 9 (–5.5 volts) and Pin10.
5. The voltage should be –5.5VDC within 2%.
6. If alignment is required, adjust potentiometer R26, located nearest the front of the instrument.

7. 5.5VDC----
   Measure the voltage with the DC voltmeter between Pin 8 (5.5 volts) and Pin 10.
8. The voltage should be 5.5 volts within 2%.
9. If alignment is required, adjust potentiometer R23 located in the center of the assembly.

SECTION VI

PARTS LIST

Mfg. Code Number	*Manufacturer*	*Location*
00853	Sangamo	Marion, Illinois
01121	Allen Bradley	Milwaukee, Wisconsin
01294	Texas Instruments	Dallas, Texas
04062	Elmenco	New York, New York
04713	Motorola	Phoenix, Arizona
05397	Kemet	Cleveland, Ohio
07263	Fairchild	Mt. View, California
12406	Elpac	Fullerton, California
14099	Semtech Corp.	Newbury Park, California
14752	Electrocube	S. Pasadena, California
15818	Amelco	Mt. View, California
24931	Specialty Connector, Co., Inc.	Indianapolis, Indiana
26533	Zero	Burbank, California
27556	IBM	Santa Fe Springs, California
28520	Heyman Mfg., Co. (Heyco)	Kenilworth, New Jersey
34160	Vu-data Corp.	San Diego, California
44655	Ohmite Mfg., Co.	Skokie, Illinois
56289	Sprague	North Adams, Massachusetts
71450	CTS	Elkhart, Indiana
71590	Centralab	Milwaukee, Wisconsin
76055	Mallory	Frankfort, Indiana
78488	Stackpole	St. Mary's, Pennsylvania
78553	Tinnerman Products	Cleveland, Ohio
80368	Sylvania	New York, New York
81073	Grayhill	La Grange, Illinois
83330	H. H. Smith	Brooklyn, New York
84171	Arco	Great Neck, New York
86684	RCA	Harrison, New Jersey
87034	Marco-Oak	Anaheim, California
88245	Useco	Van Nuys, California
90201	Mallory	Indianapolis, Indiana
91637	Dale	Columbus, Nebraska
91662	Elco	Willow Grove, Pennsylvania
92219	Waldom	Chicago, Illinois
94222	Southco	Chester, Pennsylvania
95566	Arnold Eng.	Orange, California
99800	Delevan Electric Corp.	Aurora, New York

Table 6-1. Manufacturer's Codes

Table 6-2. Parts List Power Supply

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
		RESISTORS		
R1	RC07GF270J	27 ohm, ¼W, 5%	5-10270	78488
R2	RC07GF471J	470 ohm, ¼W, 5%	5-10471	78488
R3	RN60D4993F	499Kohm, 1/8W, 1%	5-50461	91637
R4	PME75	10Mohm, 2W, 1%	5-59001	
R5	RC07GF271J	270 ohm, ¼W, 5%	5-10271	78488
R6	RC07GF473J	47Kohm, ¼W, 5%	5-10473	78488
R7	RC07GF683J	68Kohm, ¼W, 5%	5-10683	78488
R8	RC07GF102J	1Kohm, ¼W, 5%	5-10102	78488
R9	RC07GF392J	3.9Kohm, ¼W, 5%	5-10392	78488
R10	RC32GF276J	2.7Mohm, 1W, 5%	5-30276	78488
R11	RC07GF3R3J	3.3 ohm, ¼W, 5%	5-10330	78488
R12	RC20GF1R0J	1 ohm, ½W, 5%	5-22010	78488
R13	RC20GF2R0J	1 ohm, ½W, 5%	5-22010	78488
R14	RC20GF1R0J	1 ohm, ½W, 5%	5-22010	78488
R15	RC07GF270J	27 ohm, ¼W, 5%	5-10270	78488
R16	RS10WW	200Kohm, 10W	5-40102	
R17	RC07GF276J	2.7Mohm, ¼W, 5%	5-10276	78488
R18	RC07GF820J	82 ohm, ¼W, 5%	5-10810	78488
R19	RN60D3921	39.2Kohm, 1/8W, 1%	5-50356	91637
R20	360T102B	1Kohm Pot	5-73102	71450
R21	RN55D1821	1.82Kohm, 1/8W, 1%	5-51182	91637
R22	RC07GF682J	6.8Kohm, ¼W, 5%	5-10682	78488
R23	360T102B	1Kohm Pot	5-73102	71450
R24	RC07GF332J	3.3Kohm, ¼W, 5%	5-10332	78488
R25	RC07GF682J	6.8Kohm, ¼W, 5%	5-16082	78488
R26	360T102B	1Kohm Pot	5-73102	71450
R27	RC07GF332J	3.3Kohm, ¼W, 5%	5-10332	78488
R28				
R29	RC20GF221J	220 ohm, ½W, 5%	5-20221	78488
		CAPACITORS		
C1	K220E10	220 uf, 10V Tant.	6-76227	05397
C2	K220E10	220 uf, 10V Tant.	6-76227	05397
C3	ZDA7323	1 uf, 1500V Film.	6-49106	14752
C4	ZDA7323	1 uf, 1500V Film.	6-49106	14752
C5	TE1309	100 uf, 50V Elect.	6-86107	76055
C6	K220E10	220 uf, 10V Tant.	6-76227	05397
C7	39D256F 300HE4	25 uf, 300V, Elect.	6-89256	76055
C8	TE1411	30 uf, 100V Elect.	6-87306	76055
C9	DDM103	.01uf, Cer.	6-27103	71590
C10	CM05FD 470J03	47 pf, 500V Mica	6-19470	56289
C11	470J03	47 pf, 500V Mica	6-19470	56289
C12	470J03	47 pf, 500V Mica	6-19470	56289
C13	ZD2A105K	1 uf, 200V Film	6-47105	14752

Table 6-2. Parts List Power Supply (continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
C14	25V3KV	.01 uf, 3KV Cer.	6-29104	56289
C15	K4R7E50	4.7 uf, 50V Tant	6-06475	05397
C16	K4R7E50	4.7 uf, 50V Tant	6-06475	05397
C17	K47RE6	47 uf, 6V Tant	6-71476	05397
C18	K47RE6	47 uf, 6V Tant	6-71476	05397
		SEMICONDUCTORS		
Q1	2N5955	2N5955	3-27265	Jedec
Q2	2N5955	2N5955	3-27265	Jedec
Q3	2N5955	2N5955	3-27265	Jedec
Q4	2N3440	2N3440	3-23440	Jedec
Q5	2N3440	2N3440	3-23440	Jedec
Q6	2N3440	2N3440	3-23440	Jedec
Q7	TP289	TP289	3-22222	34160
		INTEGRATED CIRCUITS		
IC1	LM305	Regulator LM305	3-30305	27014
IC2	LM305	Regulator LM305	3-30305	27014
IC3	LM305	Regulator LM305	3-30305	27014
IC4	LM301A	Amplifier LM301A	3-30301	27014
		DIODES		
CR1	920A-3	Bridge 920A-3	3-19203	04713
CR2	920A-1	Bridge 920A-1	3-19201	04713
CR3	920A-1	Bridge 920A-1	3-19201	04713
CR4	920A-5	Bridge 920A-5	3-19205	04713
CR5	SCM40	Rectifier, HV,SCM40	3-10350	14099
CR6	SCM40	Rectifier, HV,SCM40	3-10350	14099
CR7	920A-3	Bridge 920A-3	3-19203	04713
CR8	IN985A	Zener, IN985A	3-10985	Jedec
CR9	IN914	G.P. IN914	3-10914	Jedec
CR10	IN914	G.P. IN914	3-10914	Jedec
CR11	IN914	G.P. IN914	3-10914	Jedec
CR12	IN914	G.P. IN914	3-10914	Jedec
CR13	IN985A	Zener IN985A	3-10985	Jedec
CR14	IN984A	Zener IN984A	3-10984	Jedec
CR15	IN914	G.P. IN914	3-10914	Jedec
CR16	IN914	G.P. IN914	3-10914	Jedec
CR17	IN914	G.P. IN914	3-10914	Jedec
CR18	IN914	G.P. IN914	3-10914	Jedec
CR19	IN914	G.P. IN914	3-10914	Jedec
CR20	IN977A	Zener IN977A	3-10977	Jedec
CR21	IN699A	Zener IN969A	3-10969	Jedec

Table 6-2. Parts List Power Supply (continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
		MISCELLANEOUS		
T1	7012017	Transformer	7-61002	34160
	7013005	Etched Circuit Board	1-20022	34160

Table 6-3. Parts List Rack Chassis

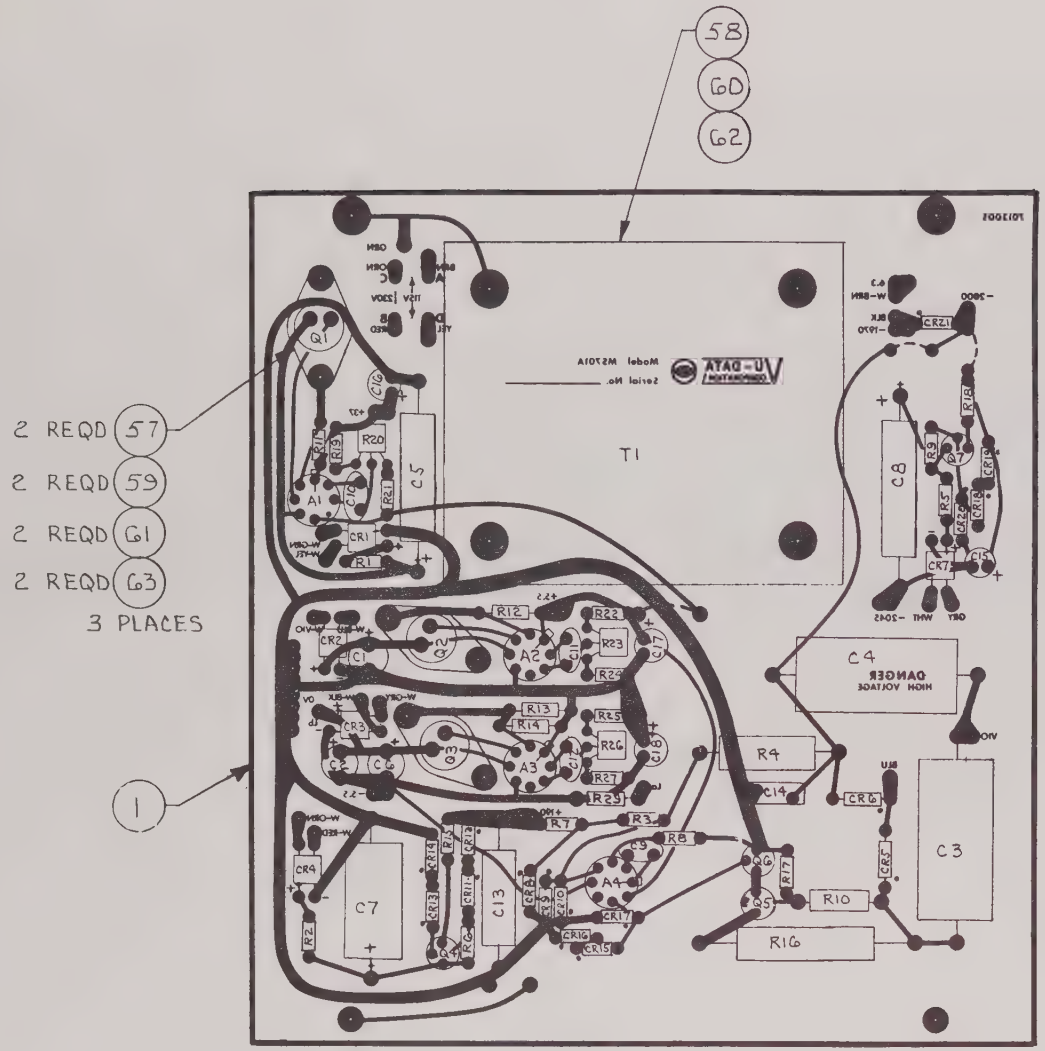
REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
		RESISTORS		
R1-A thru R16-A	RC20GF102J	1Kohm, ½W, 5%	5-20102	78488
R1B thru R8B	RC20GF102J	1Kohm, ½W, 5%	5-20102	78488
		CAPACITORS		
C1A thru C8A	UK20X104	0.1 uf 100V	6-27107	04062
C1B thru C8B	UK20X104	0.1 uf, 100V	6-27107	04062
		MISCELLANEOUS		
S1A	8XF12.5-4V/GR	Switch PC	2-10010	IEE
S1B	8XF12.5-4V/GR	Switch PC	2-10010	IEE
	7003002	Etch. Circuit Board	1-20021	34160
	00-7008-017-141-001	Connector, Elco	2-27008	91662
	4890-7/4890-1	Connector, BNC	2-28999	Dage
	UG1094/V	Connector, BNC	2-28998	
	7101	Switch, Power	2-10003	87034
	MV5023	Diode Light Emitting	3-15023	
	342004	Fuse Holder	2-40000	75915
	3AG¼SB	Fuse ¼ Amp	2-40004	71400
	# 1523	Strain Relief	2-45000	28520
	17405B	Power Cord	2-70000	Beldon

SECTION VII

DRAWINGS

List of Drawings:

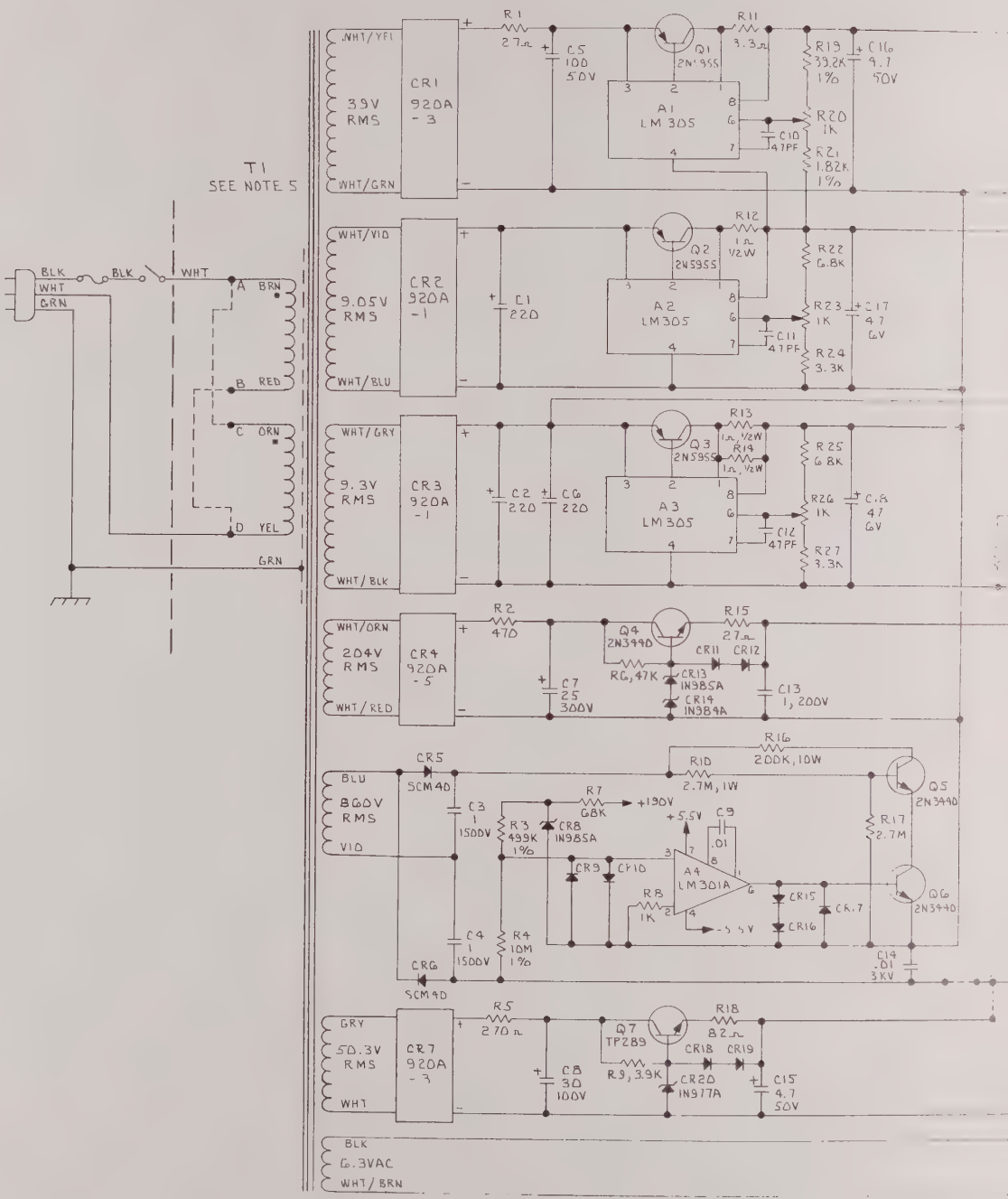
Figure 7-1. MS701 Power Supply Parts Locations
Figure 7-2. Power Supply Schematic



WIRE TABLE	
FROM	TO
T1-BRN	CKT BD-BRN
-RED	-RED
-ORN	-ORN
-YEL	-YEL
-GRN	-GRN
-WHT/ORN	-W-ORN
-WHT/RED	-W-RED
-WHT/YEL	-W-YEL
-WHT/GRN	-W-GRN
-WHT/VIO	-W-VIO
-WHT/BLU	-W-BLU
-WHT/GRY	-W-GRY
-WHT/BLK	-W-BLK
-BLU	-BLU
-VIO	-VIO
-GRY	-GRY
-WHT	-WHT
-BLK	-BLK
T1-WHT/BRN	CKT BD-W-BRN

Figure 7-1. Power Supply Parts Location

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE DISCLOSED TO OTHERS REPRODUCED OR USED WITH OUT WRITTEN AUTHORITY FROM
VU-DATA CORPORATION



5. FOR 115 VAC - JUMPER A-C, B-D
   FOR 230 VAC - JUMPER B-C
4. LAST NO'S USED: A4, C18, CR21, Q7, R29, T1
3. DIODES ARE IN914
2. CAPACITORS ARE IN MICRO FARADS
1. RESISTORS ARE IN OHM'S, 5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED

4 3 2 1

REVISIONS

REV	DESCRIPTION	DATE	APPROVED

+ 37V

DV

- 5.5V

- 5.5V

+190V

- 2000V

-1970V

-2045V

D C B A

7011005

ITEM NO	QTY REQD	DESCRIPTION	SCHEM DES	VU-DATA PN	MIL OR VENDOR PN	CODE OR SPEC NO

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± DECIMALS .X ±.050
ANGLES ± .XX ±.030
SURFACE FINISH ✓ .XXX ±.010
MATERIAL
FINISH

CONTRACT NO.
DRAWN H. Johnson 5-19-71
CHECKED
ENGINEER
APPROVED
APPROVED
APPROVED
CUSTOMER APPROVAL
RELEASE

VU-DATA CORPORATION SAN DIEGO, CALIFORNIA

SCHEMATIC - POWER SUPPLY MODEL MS701A

SIZE	CODE IDENT NO	DRAWING NO	REV
D	34160	7011005	

SCALE NONE SHEET 1 OF 1

PART NO	QTY REQD	NEXT ASSEMBLY	USED ON
			MS701A

APPLICATION

4 3 2 1

SERIES MS700 (R)
MONITOR OSCILLOSCOPES

TECHNICAL MANUAL

VU-DATA CORPORATION
7595 Convoy Court
San Diego, California 92111
Phone 714-279-6572

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SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. This manual contains complete operation, calibration and maintenance instructions for the Model MS240 Monitor Oscilloscope.

1-3. The purpose of this manual is to provide the operation and maintenance information required by the equipment operator or service technician. The manual does not include information pertaining to special equipment applications, nor does it include instructions for accomplishing repairs of the type performed at the factory.

1-4. The manual is divided into eight sections. Section I provides general information regarding the purpose of the equipment, its physical arrangement, and its pertinent specifications. Section II contains information on installation and unpacking. Section III contains instructions for operating the equipment. Section IV describes the theory of operation of the equipment circuits and mechanisms. Section V provides test, alignment, and maintenance procedures. Section VI contains a complete parts list. Section VII contains complete circuit drawings. Section VIII provides a list of recomended spares.

1-5. PHYSICAL DESCRIPTION

1-6. Model MS240 Oscilloscope

1-7. The Model MS240 Oscilloscope is constructed on a single PC board to facilitate ease in calibration and maintenance. Integrated circuits, silicon semiconductors and tantalum capacitors are used exclusively. The PC board has its principle components identified by reference designator and all diodes and tantalum capacitors are identified for polarity.

1-8. The front panel vertical and horizontal control sections are separated to facilitate operation of each oscilloscope module. Either of two input channels can be displayed on the 1 1/2" x 3" cathode ray tube (CRT) by a switch located on the front panel. The CRT is secured within a milled out area behind the front panel, thus bringing the display closer to the front panel to enhance the ease of viewing. A photo positive graticule, made on clear mylar is inserted in the milled out area between the tube and front panel. This eliminates the problem of realigning new tubes when replacement is required. This milled out area can also be utilized for the use of a filter by moving the tube slightly to the rear and inserting the filter between the tube and the graticule.

1-9. Rack slides provided with every chassis facilitate access through the top panel to the rear controls for each oscilloscope module. The intensity, controlled by 2000VDC acceleration voltage, ensures a bright display even at high frequencies. The module design employs a dual, back to back transistor circuit to essentially eliminate vertical drift under low or high temperature environments.

1-10. Application

1-11. The Series MS240 Monitor Oscilloscopes provide continuous monitor of analog and digital signals for real time observation of numerous electrical and physical phenomena under various test conditions. They also ensure reliable recording of such phenomena on magnetic tape. In the typical instrumentation tape recording system, three specific functions are served:

a. Each recording track can be observed to ensure the record/reproduce electronics is properly adjusted to give a reproduce signal which is equal to the input signal recorded.

b. The input signals can be continuously monitored to ensure that desired information is being recorded and to provide an immediate alert to system noise and ground loop problems or loss of signal.

c. Recorded data can be reproduced and observed for analysis and to guarantee that the desired data has been recorded.

1-12. FUNCTIONAL DESCRIPTION

1-13. The basic purpose of any oscilloscope is to present a visual signal on the face of a cathode ray tube (CRT). The signals are conditioned into waveforms and displayed on the CRT for use of the operator in analyzing the input signal. The ability to reproduce these signals accurately and in a manner of convenience to the operator is of prime importance.

1-14. Each of the oscilloscope modules is a plug in assembly utilizing a common power supply, consisting of a single PC assembly which furnish the necessary voltages to operate the circuits in each oscilloscope.

1-15. The oscilloscope module is divided into 2 basic sections, Vertical and Horizontal. Each section consists of the circuits necessary to condition the drive to the vertical and horizontal deflection plates of the CRT. The two dimension CRT display which results is representative of the signal amplitude (Vertical) and frequency or time interval (Horizontal) most convenient for meaningful analysis.

1-16. The information contained in this section will show the interrelation of the major functional elements of the instrument and how they operate together to achieve a desired display. The text will be on a simplified basis showing controls and major areas with references made to a block diagram of the complete module.

1-17. Vertical Circuit

1-18. The function of the vertical circuits is to condition the input signal prior to its application to the CRT's vertical deflection plates. The vertical section is divided into three primary parts which are:

a. INPUT SWITCHING

b. VERTICAL ATTENUATOR

c. VERTICAL AMPLIFIER

1-19. Input Switching

1-20. The input switching is comprised of two switches, the input selection switch S1, and the AC/DC coupling switch, S2.

1-21. The input selection switch selects one of three input modes which are Channel A (REC or record input), Channel B (REP or reproduce input), or signal ground position (ZERO). The AC/DC coupling switch, S2 is a 2 position toggle switch which couples the input signal either directly or AC coupled to the Vertical attenuator. Capacitor C1, a 0.1 microfarad is used in the AC mode to remove unwanted DC components. In the DC mode, the capacitor is bypassed and the signal is coupled directly to the vertical amplifier.

1-22. Vertical Attenuator

1-23. The vertical attenuator utilizes a printed circuit switch S3, to select the attenuation position required to reduce the input signal amplitude to 50mv P-P per division. In the 50mv position the vertical attenuator is bypassed. In the other six positions, .1v, .2v, .5v, 1v, 2v, and 5v the input signal is attenuated through an RC attenuator. The resistance portion attenuates the low frequencies

and the capacitive portion which is adjustable, attenuates the high frequency signals.

1-24. Vertical Amplifier

1-25. The vertical amplifier amplifies the attenuated signal, as necessary to provide a 1" full scale deflection on the CRT. Resistor R88 is the factory set control of the gain of the amplifier. The vertical amplifier consists of 3 differential transistor stages, Q1, Q2, Q3, Q4 and sections C, D, and E of IC1. The vertical positioning control R91, located on the rear is used to position the vertical signal on the face of the CRT.

1-26. Horizontal Circuit

1-27. The function of the horizontal section is to provide a time reference for the CRT display. A linear ramp wave is generated which is used for the sweep signal. The sweep signal is applied to the horizontal deflection plates. Five basic circuits comprise the Horizontal section which are:

a. TRIGGER AMPLIFIER

b. TRIGGER GENERATOR

c. SWEEP GENERATOR

d. HORIZONTAL AMPLIFIER

e. BLANKING CIRCUIT

1-28. Trigger Amplifier

1-29. The generation of the linear ramp is controlled by the trigger signal. This trigger signal is derived from the input signal or from an external signal other than the input signal. A toggle switch, S5, located on the rear porch allows the operator to select either internal or external trigger. The signal is applied to the trigger amplifier consisting of IC2, sections C and D where it is amplified prior to entry into the trigger generator. This amplification enables the oscilloscope to have extremely high trigger level sensitivity.

1-30. Trigger Generator

1-31. The trigger generator is a Schmitt trigger multivibrator IC1, sections A and B, which generates a square wave with a fast rise and fall time of approximately 15 nano-seconds. The switching time of the trigger generator occurs at the start of each cycle. Switch S5 determines the selection of either the positive or negative slope of the input signal on which the Schmitt trigger will fire. The square wave is then differentiated and applied to the sweep generator.

1-32. Sweep Generator

1-33. The sweep generator generates the linear ramp wave form (sweep signal). The principal components used are sections A, B, and E of IC2, IC3, Q5, Q14 and Q16. The negative spike from the differentiated square wave is used to trigger this sweep signal. The slope of the ramp is established by the Horizontal Frequency switch S4, located on the front panel. This slope is continuously variable between ranges by the use of the X10 Vernier control R97, located on the front panel. The slope of the ramp determines the rate at which the beam is moved along the horizontal axis.

1-34. Two additional controls in the sweep generator are used in conditioning the sweep signal. R50 establishes the sweep stability, and R41 sets the sweep calibration. Both of these controls

are mounted on the module PC board and are preadjusted at the factory.

1-35. Horizontal Amplifier

1-36. The sweep signal is amplified in the horizontal amplifier. The amplitude of the sweep signal is adjusted by R53, sweep length control, to coincide with the full length of the graticule's horizontal azis. Because a triggered sweep is employed, the beam will always start its movement from left to right of the CRT at the same point on the input wave form. The horizontal positioning control, R89, located on the rear porch is used to position the horizontal signal on the face of the CRT. The principle components used in the horizontal amplifier are Q6, Q7, Q8, and Q15.

1-37. Blanking Circuit

1-38. At the completion of each sweep, the sweep signal trailing edge returns the beam to the extreme left side of the CRT graticule in preparation for commencement of the next sweep cycle. Since the viewing of the spot or trace during the return or "flyback" of the beam is undesirable for the observer, a blanking circuit is included which detects the end of the sweep and generates a signal which is applied to the grid of the CRT. This signal turns off the beam at the completion of the sweep and holds it off until the start of the next sweep. The principle components used in the blanking circuit are Q9 through Q13.

1-38. CONDENSED DATA

1-40. Table 1-1 is a tabulated list showing tubes, semiconductors, plug in modules, printed circuit cards and fuse complements. Electrical and mechanical characteristics are given in the specifications, Paragraphs 1-41 and 1-42, and in Figure 1-1.

REFERENCE DESIGNATOR	DESCRIPTION	VU-DATA PART NO.
A2F1	3AG SB1A Fuse	2-40003
A1V1	Cathode Ray Tube, P31	3-40000
A1Q1	TP290	3-22369
A1Q2	TP290	3-22369
A1Q3	Field Effect	3-21837
A1Q4	Field Effect	3-21837
A1Q5	GT2907	3-22907
A1Q6	SE7056	3-27056
A1Q7	SE7056	3-27056
A1Q8	2N3694	3-23694
A1Q9	2N3694	3-23694
A1Q10	GT2907	3-22907
A1Q11	2N3694	3-23694
A1Q12	GT2907	3-22907
A1Q13	2N3694	3-23694
A1Q14	Field Effect	3-21837
A1Q15	2N3694	3-23694
A1Q16	2N3694	3-23694
A1IC1	CA3046	3-33046
A1IC2	CA3046	3-33046
A1IC3	LM301A	3-30301
A2A1IC1	LM305	3-30305
A2A1IC2	LM305	3-30305
A2A1IC3	LM305	3-30305
A2A1Q1	2N5955	3-27265
A2A1Q4	2N3440	3-23440

Table 1-1. List of Tubes, Semiconductors, and Fuses

1-41. ELECTRICAL SPECIFICATIONS

VERTICAL

BANDWIDTH:	DC–5 MHz within ±1 dB; DC–10 MHz within ±3 dB.
INPUT–	
MODE:	Toggle switch on each Oscilloscope Module allows selection of signal ground or Channels A and B, with 8 inputs per channel, push button selectable.
COUPLING:	AC or DC.
IMPEDANCE:	1 Mohm in parallel with 100pf for all ranges.
ISOLATION:	Signal and external trigger BNC connectors are isolated and floating from case and power line ground by 10,000 Mohm. Strap on power supply board allows signals to be terminated or floated.
RANGE:	50 mV p-p/div to 5V p-p/div in seven calibrated steps of 1, 2, 5 sequence.
SENSITIVITY:	Maximum of 50 mV p-p/div.
ACCURACY:	Within ±3% of full scale.
DRIFT:	5% of full scale upon application of power. No detectable drift after 30 minutes warm-up.

HORIZONTAL

SWEEP RATE:	1 usec/div to 10 msec/div in 5 calibrated decade steps; X10 vernier control extends time base to 0.1 usec/div.
ACCURACY:	Within ±3% of full scale.
LINEARITY:	Within ±3% of full scale.
TRIGGER–	
MODE:	Selectable internal or external; automatic to 10 Hz–10 MHz.
SLOPE:	Internal: Selectable positive or negative. External: Positive.
LEVEL:	Internal: 0.1 in. vertical deflection. External: 0.5 V p-p.

1-42. GENERAL SPECIFICATIONS

PHOSPHOR:	P31 standard; P2, P7 and others available upon request.
GRATICULE:	1/4" per major division; 4 vertical and 10 horizontal.
CRT ANODE VOLTAGE:	2,000 volts.
OPERATING TEMPERATURE:	0^{o}C to +55^{o}C.
POWER:	115 VAC ±10% or 230 VAC ±1-% selected by power supply board strapping; 50-400 Hz; 20 watts for Power Supply/Rack Chassis with 2 each Oscilloscope Module.
DIMENSIONS:	1 3/4" H x 17" W x 16" D (4.44cm x 43.18cm x 40.64 cm); slides provided with each chassis for mounting in standard 19" RETMA rack.
WEIGHT:	Approximately 15 lbs (6.8 kg); add 5 lbs (2.3 kg) for shipping.

SECTION II

INSTALLATION

2-1. INSPECTION UPON RECEIPT

2-2. The Series MS240 is aligned, calibrated, and tested under severe environmental conditions prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure that the instrument has suffered no damage in shipment.

a. A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier. If extensive damage of the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be kept for inspection.

b. A visual inspection for damage should be accomplished upon removing the instrument from the shipping container. Remove the top cover and check for loose or broken components. Check to see that the printed circuit boards are mated with their connectors and are well seated. Remove each module and check for loose or broken components.

SECTION III

OPERATION

3-1. OPERATING CONTROLS

3-2. All of the controls necessary for the operation of the Series MS240 Monitor Oscilloscope are located in such a way to facilitate the ease in operation required by the operator.

CONTROL	POSITION	FUNCTION	LOCATION
INPUT SELECTOR	A	Signal selected by Channel A selector switch is displayed on CRT and Ext. trigger for respective input is connected to Module Ext. Trigger Input.	Front panel of MS240
	GRD	The input to the module is connected to electrical ground.	
	B	Signal selected by Channel B selector switch is displayed on CRT	
AC/DC	DC	Input signal is direct coupled to the module input.	Front panel of MS240
	AC	Input signal is AC coupled to the module input.	
VERTICAL ATTENUATOR (V/DIV)	.05v	Input signal to the module is not attenuated.	Front panel of MS240
	.1v	Input signal to the module is .1v per division.	
	.2v	Input signal to the module is .2v per division.	
	.5v	Input signal to the module is .5v per division.	
	1v	Input signal to the module is 1v per division.	
	2v	Input signal to the module is 2v per division.	
	5v	Input signal to the module is 5v per division.	
SWEEP RATE (M sec/div)	10msec	Horizontal time base is 10msec to 1msec per division.	Front panel of MS240
	1	Horizontal time base is 1msec to .1msec per division.	
	.1	Horizontal time base is .1msec to .01msec per division.	
	.01	Horizontal time base is .01msec to .001msec per division.	
	.001	Horizontal time base is 1usec to .1usec per division.	

Table 3-1. Function and Location of Operating Controls

CONTROL	POSITION	FUNCTION	LOCATION
VERNIER	VAR	Provides continuous adjustment between each range of horizontal time base.	Front panel of MS240
	CAL	Horizontal time base is calibrated at the rate indicated by the sweep rate switch.	
POSITION VERT	VAR	Vertical Positioning	Rear Porch of MS240
POSITION HORIZONTAL	VAR	Horizontal Positioning	Rear Porch of MS240
FOCUS	VAR	Focus the display on CRT.	Rear Porch of MS240
ANGLE	VAR	Adjust the angle of the trace on the CRT.	Rear Porch of MS240
INTENSITY	VAR	Adjusts the intensity of the display on the CRT	Rear Porch of MS240
TRIGGER	+	Signal trace will trigger on the positive portion of the input signal.	Rear Porch of MS240
	EXT	Signal trace will trigger as determined by the external signal applied to the Input Terminals on the rear panel of the MS701.	
	–	Signal trace will trigger on the negative portion of the input signal.	

Table 3-1. Function and Location of Operating Controls (Continued)

3-3. Pre-Operational Adjustments

3-4. The Series MS240 Monitor Oscilloscope has been pre-adjusted at the factory and therefore should require no special adjustments prior to operation.

WARNING

The voltages used in the Model MS240 Oscilloscope modules are lethal. Precautions should be used when working on the instruments when the top cover is removed.

3-5. Before applying power to the Series MS240, the unpacking procedure, (reference paragraph 2-1) must be accomplished to ensure the instrument has suffered no damage in shipping or handling.

3-6. Prior to performing any electrical tests, the MS240 (2 each in the MS700) should be positioned as follows:

CONTROL	POSITION
Vertical	Centered
Horizontal	Centered
Trace Angle	Centered
Focus	Centered
Intensity	CW
Trigger	+
A-B Switch	Gnd
AC/DC Switch	DC
V/Div	.05
msec/Div	10msec
X10 Vernier	CAL

3-7. Preliminary Operation

3-8. With the controls as shown in paragraph 3-11, insert the power cord into a 115VAC ±10% 50 to 400 Hz power source.

3-9. Switch the power switch to on and the power indicator should light.

3-10. Control Verification

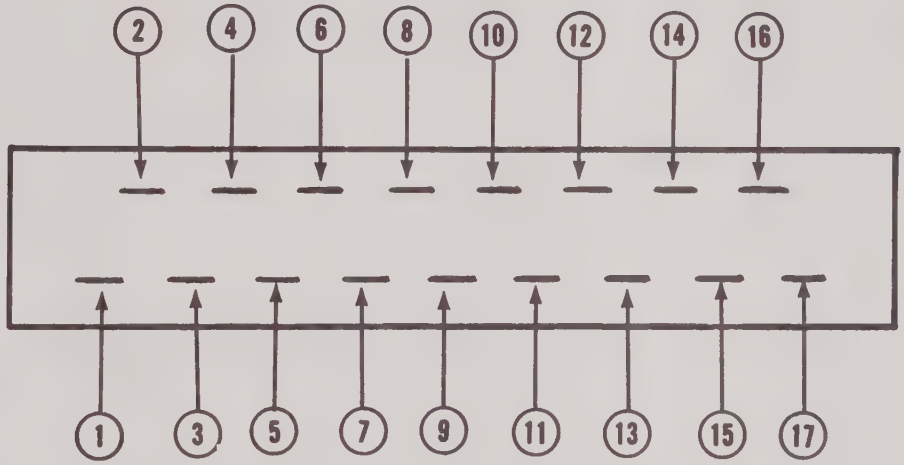
3-11. If the unit is functioning properly, a slow moving trace should appear on the face of each CRT. The procedure given in Table 3-2 should be followed to verify the operation of each control.

CAUTION

Do not leave the intensity control in the maximum clockwise direction with a continuous display for long periods of time as phosphor burns on the CRT will occur.

3-12. Post Operational Procedures

3-13. The Series MS240 requires no preventive procedures when the instrument is not in use other than good housekeeping practices of cleanliness. Should the instrument be defective or fail to meet the requirements of Table 3-2, the maintenance section should be consulted for possible correction measures. If information is desired from one of our Field Representatives or Vu-data Corporation, consult the warranty section of this manual.



FRONT VIEW

1	BLANK	10	0VDC (Circuit Common)
2	-2000VDC	11	+40VDC
3	– 2045VDC	12	+190VDC
4	6.3AC	13	REP INPUT LOW
5	- 1970VDC	14	REP INPUT HIGH
6	BLANK	15	REC INPUT LOW
7	EXTERNAL TRIGGER	16	REC INPUT HIGH
8	+5.5VDC	17	LIGHT RETURN
9	– 5.5VDC		

Figure 3-1. Connector Pin Locations for Internal Connector

STEP NO.	CONTROL	DESCRIPTION
1.	Intensity	Adjust the Intensity control located on the rear porch for a desired intensity.
2.	Focus	Adjust the Focus control, R93, for a minimum trace width. The control should have sufficient range to de-focus on both sides of the optimum setting.
3.	Vertical	Vary the Vertical positioning control, R91, located on the rear porch. The control should swing the horizontal trace from the top to the bottom of the CRT face (minimum). Position the trace to the center of the graticule.
4.	Horizontal	Vary the Horizontal positioning control, R89, located on the rear porch. The control should vary the trace over a minimum range of 5 major divisions.
5.	Trace Angle	Vary the trace angle control, R92, located on the rear porch, through its range. The trace must align with the graticule.
6.	Input Selector	Apply a signal to the A Input Connectors. The Signal should be a 1KHz sine wave with an amplitude of approximately 0.2v PP, set msec/Div switch to 1msec. Set switch S1, located on the front panel to the A position. A sine wave should appear on the CRT face with an amplitude of approximately full scale.
7.	Input Selector	Apply a signal of the same frequency and amplitude to the B inputs. Set the Input selector to B. A sine wave should appear on the CRT face with an amplitude of approximately full scale.
8.	Vertical Attenuator	With the signal on the face of the CRT, rotate switch S3, Vertical Attenuator located on the front panel, through its 5 positions and note that with each position in a counter clock-wise direction, the amplitude of the waveform decreases. Return the switch to the .05 position.
9.	Horizontal Sweep Rate	With the input signal on the face of the CRT, rotate Switch S4, Horizontal Sweep Rate switch located on the front panel through all seven of its positions and note that with each position in a clock-wise direction, the sweep rate is increased. Return the switch to the 1msec position.
10.	X10 Vernier	With the input signal on the face of the CRT, rotate the X10 vernier control, R97, located on the front panel from its calibrated position in a clock-wise position, the sweep rate should be increased by a factor of at least 10.

Table 3-2. Control Verification Procedure

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

4-2. The basic function of an oscilloscope is to allow the operator to view and investigate waveforms from other instruments and sources. This requires four basic tasks to be accomplished to allow the oscilloscope to function properly.

a. The waveform to be viewed must be conditioned to the proper amplitude prior to application to the vertical portion of the cathode ray tube (CRT).

b. A signal must be generated and applied to the horizontal portion of the CRT which allows the proper portion of the waveform to be displayed.

c. A signal must be generated and applied to the grid of the CRT which turns the tube on during the time of the display and off during the retrace time.

d. A CRT to display a visual display of the signal is applied.

These tasks are accomplished in the Vu-data MS240 Monitor Oscilloscopes.

4-3. Two plug-in printed circuit assemblies comprise the instrument's power supply circuits. These assemblies are located in the Rack Chassis and provide the power requirements for the modules. The power supply voltages, along with the input signals and external trigger are supplied to each oscilloscope module by the printed circuit connectors located on the master assembly.

4-4. Vertical Circuits

4-5. The vertical signal conditioning circuitry is made up of three sections. (1) Vertical input Switching, (2) Vertical Attenuator and (3) Vertical Amplifier.

4-6. Vertical Input Switching

4-7. The vertical input switching is accomplished by switches S1, (input selector) and S2 (AC/DC). The input signal is supplied to S1 from the A input, or from the B input. The signals are supplied to connectors by coaxial cables from the appropriate channel connectors on the rear of the rack chassis. The signal is then coupled to S1 by coaxial cables through connector J101. Switch S1 selects either of the two input signals or circuit ground. The arm of S1 is connected to the AC/DC switch.

4-8. AC/DC Switch

4-9. The AC/DC switch (S2) has two positions, AC or DC. When S2 is in the AC position, the AC input signal is coupled through capacitor C1, which removes the DC component from the signal applied to the vertical attenuator.

4-10. When S2 is in the DC position, the input AC or DC signal is directly coupled to the vertical attenuator.

4-11. Vertical Attenuator

4-12. The vertical attenuator, Switch S2, provides 7 selectable positions of attenuation of the signal before applying it to the vertical amplifier. The attenuator output of 0.2 volts p-p will provide one inch of vertical deflection on the CRT.

4-13. The low frequency portion of the input signal is attenuated through the resistive networks and the high frequencies are attenuated through the capacitive networks of the attenuator. When

properly compensated, the RC network at the top portion of the attenuator is equal to the RC network at the bottom portion. The attenuator has a minimum attenuation of zero (0.2v p-p/inch) to a maximum attenuation of 100 (20.0v p-p/inch) in seven steps.

4-14. The attenuator consists of switch S3, Resistor R1 through R13 and Capacitor C2 throuch C13.

4-15. Vertical Amplifier

4-16. The vertical amplifier is a differential amplifier utilizing field effect transistors for the inputs. The field effect transistors (FETS) Q3 and Q4 provide high input impedance and thermal tracking to establish the automatic temperature compensation. The input at Q4 is the arm of the vertical positioning control R91. Integrated circuit (IC), IC1, sections c and d are emitter follower transistors which provide a low impedance drive to the final amplifiers, Q1 and Q2. Resistors R16, R17, R18 and R38 provide biasing for IC1e.

4-17. Variable resistor R88 is the vertical gain control and is used to establish the calibration of the vertical amplifier. R31 and R32 are used to provide the collector loads for Q1 and Q2. Inductors L1, L2, L8 and L9 along with resistors R33, R34 and capacitor C12 provide the high frequency compensation to maintain the bandwidth of 10 MHz.

4-18. Resistor R27 couples a portion of the signal from the emitter of IC1c to the emitter of IC1d which causes R19 and R22 in the collectors of these transistors to provide a differential signal to the trigger polarity switch, S5. CR1 and CR2 are protection diodes on the input which conduct when the input signal exceeds the power supply voltages. R14 limits the current under overload conditions. CR13 and CR14 limit the range of the vertical positioning control to approximately +0.7 volts. C16 bypasses the high frequency noise from the positioning input to Q4. R35, R37, C17 and C18 provide de-coupling of the +5.5 VDC supplies which provide the power to the vertical circuits. R83 and R84 provide a current path for the vertical positioning control R91. R36 and C15 provide de-coupling of the +40 VDC supply.

4-19. Horizontal Circuits

4-20. The horizontal signal is developed by 4 blocks of circuits, (reference block diagram Figure 4-1.). The circuits are:

1. Trigger Amplifier
2. Trigger Generator
3. Sweep Generator
4. Horizontal Amplifier

4-21.Trigger Amplifier

4-22. The signal used in generating the trigger is selected by switch S5 from either one of the differential outputs of the vertical amplifier or from the external trigger input. The output from this switch is coupled through capacitor C30, a 0.1ufd capacitor to the trigger amplifier. Diodes CR3 and CR4 provide protection, limiting the voltage swing at the input of the trigger amplifier. The trigger amplifier consists of Integrated Circuit IC2c and IC2d. Resistors R40 and R42 provide the DC bias for the emitter follower transistor IC2. IC2 amplifies the trigger signal by a factor of approximately 5.

4-23. Trigger Generator

4-24. The amplified trigger signal is applied through capacitor C41 to the free running Schmitt trigger multivibrator. The multivibrator, Integrated Circuit, Sections IC1a and IC1b free run at

approximately seven cycles per second. The free running rate of the multivibrator is determined by the value of capacitor C41, Hysteresis of the multivibrator, input impedance to the multivibrator and the output impedance of the trigger amplifier. When a signal is applied to the multivibrator, the frequency of the multivibrator will increase to the rate of the incoming signal. Resistor R47 controls the hysteresis of the multivibrator. Capacitor C31 is a high frequency speed up capacitor which provides a very fast rise time during the switching portion of its operation. The output of the trigger generator is taken from pin 5 of IC1b and differentiated by capacitor C33 and applied to the sweep generator.

4-25. Sweep Generator

4-26. The sweep generator is an integrator gated by a Schmitt trigger multivibrator consisting of Integrated Circuit IC2, sections a and b. When the sweep generator is quiescent and waiting to be triggered, IC2a is on and IC2b is off. When IC2b is off, its collector sets FET switch Q14 on which connects the output of IC3, pin 6 to the negative input pin 2, through the ON impedance of the FET. This sets the output level of the operational amplifier at +5.5 VDC established by the +5.5 VDC supply voltage connected to pin 3, the + input of the operational amplifier. When a negative pulse is passed through the differentiation capacitor C33, the Schmitt multivibrator flips which turns ON IC1b. This turns OFF Q14 and starts charging the sweep capacitor selected by switch S4 (Horizontal Frequency Switch). The capacitor charges from the current derived through resistors R39 and R97. As the capacitor charges, the output from IC3, pin 6 increases. When this voltage reaches approximately 25 volts, the level at the emitter of IC2e becomes sufficiently positive to forward bias CR6 which turns ON IC2a and reverses the process. When IC2a is turned ON IC2b is turned OFF, Q14 is turned ON, which discharges the sweep capacitor. This returns the output of the operational amplifier IC3 to approximately +5.5 VDC until another negative pulse flips the Schmitt multivibrator. Holdoff capacitors C23 and C27, also selected by switch S4, maintain IC2a in an ON condition by holding a forward bias on diode CR6 until FET Q14 has completely discharged the sweep capacitor and established the output level of IC3 to +5.5 VDC. This prevents any pulse through capacitor C33, starting a new sweep before the sweep generator output has returned to its quiescent state.

4-27. The rate at which the sweep capacitors will charge is dependent on the current supplied through resistors R39 and R97 which determine the setting of the sweep calibration potentiometer R41 and the X10 vernier control R97. Diode CR10 is a zener which provides a positive supply voltage to IC3. Capacitor C32 is a speed-up capacitor allowing for faster operation of the Schmitt multivibrator. The sweep signal is being generated and provides a low impedance drive to the blanking circuit.

4-28. Horizontal Amplifier

4-29. The output of the sweep generator is applied to the horizontal amplifier. The horizontal amplifier consists of transistor Q6, Q7, Q8 and Q15. The amplifier is a differential operational amplifier with one input supplied by Q15 from the horizontal position control. The other input is the output of the sweep generator.

4-30. Transistor Q8, Resistors R57, R58 and R59 provide a constant current for Transistors Q6 and Q7. Resistors R49, R54, R64 and R65 are the input resistors. Resistor R67 and R68 are the feedback resistors. Resistors R53 and R56 vary the gain of the horizontal amplifier without affecting the DC level of the output. Resistors R69 and R70 are the amplifiers collector load resistors. Inductors L3, L4 and capacitors C37 and C42 are high frequency compensation components used for increasing the overall band-width of the amplifier. Capacitor C38 removes unwanted AC signals from the horizontal position line. Resistors R86 and R87 provide a current path for the horizontal position control, R89.

4-31. Blanking Circuit

4-32. The blanking circuitry consists of a bi-stable multivibrator. The bi-stable multivibrator consists of transistors Q9, Q10, Q11 and Q12 and the voltage setting transistor, Q13. A signal from the sweep gating multivibrator, emitter of Q16, is coupled through capacitor C39 to the blanking circuitry. Capacitor C39 provides the extreme high voltage isolation required. When the sweep starts the signal, the output of the gating multivibrator goes negative which turns OFF transistor Q9 and turns ON transistor Q12. This turns transistor Q10 OFF and transistor Q11 ON forcing the voltages at the emitter of transistors Q11 and Q10 positive to the level of the emitter of transistor Q13. The level of voltage at transistor Q13 is set by the intensity control. This positive going voltage is applied to the grid of the cathode ray tube, turning it ON. At the end of the sweep, the output of the gating multivibrator goes positive and turns ON transistor Q9 and turns OFF transistor Q12. This turns ON transistor Q10 and turns OFF transistor Q11. The voltages at the emitters of transistors Q10 and Q11 go to a negative −2045 VDC. This voltage negative biases the CRT, which turns it off. The CRT will remain OFF until the gating multivibrator in the sweep generator goes negative, starting the next sweep. Potentiometer R90, the intensity control, sets the voltage at the base of transistor Q13 controlling the voltage on the emitter of transistor Q13. This determines the positive voltage to which the multivibrator will swing.

4-33. Resistors R72, R73, R76, R77 and R98 are biasing and pulse forming resistors for the multivibrator. Resistors R74 and R75 provide DC current to the portions of the circuit which are on. Diodes CR11 and CR12 limit the voltage on each half of the switch. Capacitor C40 provides DC isolation of the trigger signal applied to the two portions of the switch.

4-34. Focus Control

4-35. Resistor R93 is the focus control. It varies the potential on the focusing element of the CRT for minimum spot size.

4-36. Trace Angle Control

4-37. Potentiometer R92 varies the current through the trace angle coil for proper horizontal alignment of the graticule. This control varies the angular rotation of the trace on the CRT to compensate for CRT misalignment.

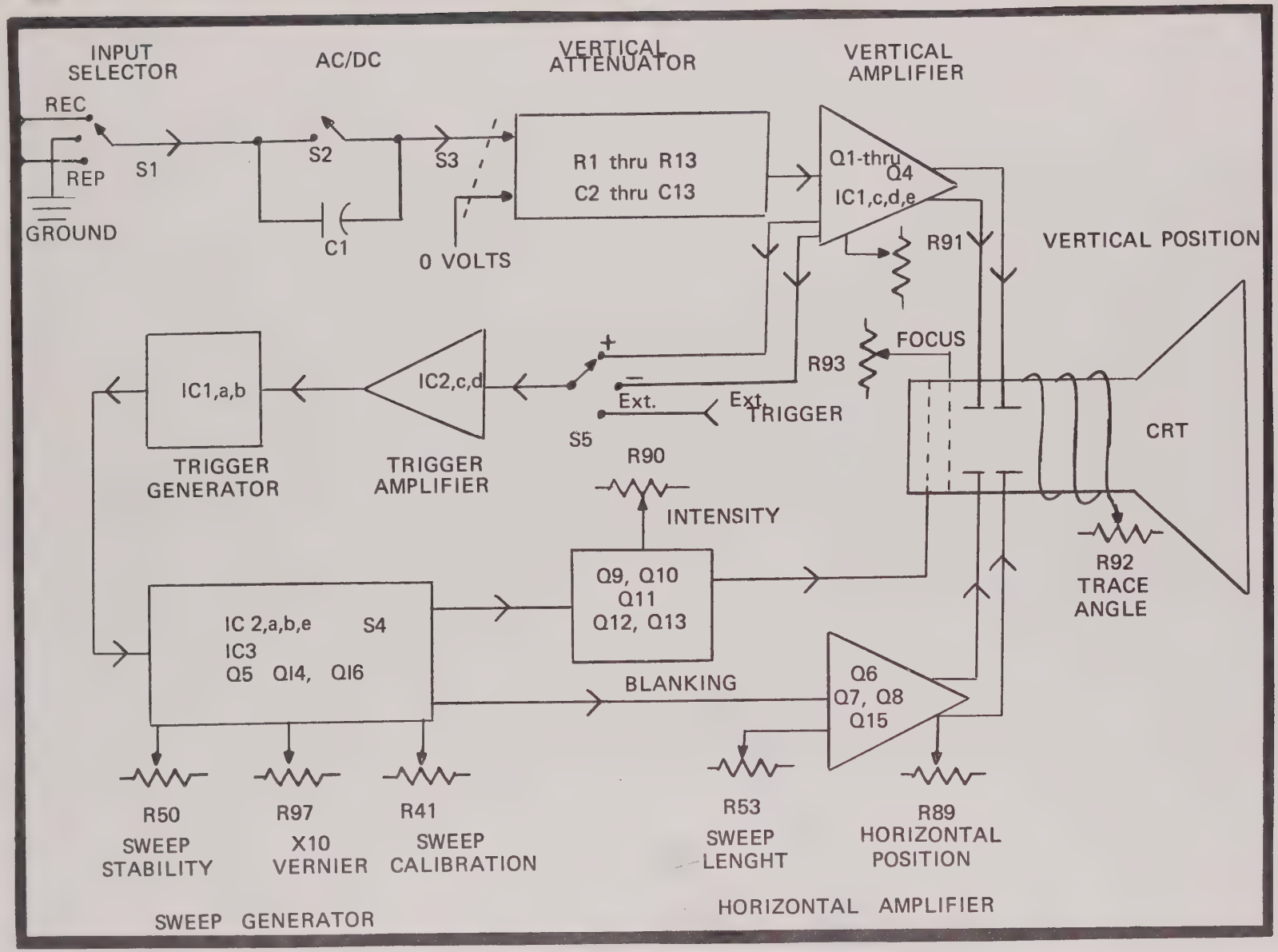


Figure 4-1. Block Diagram, Model MS240 Monitor Oscilloscope

SECTION V

MAINTENANCE

5-1. GENERAL

5-2. The following procedure provides the information necessary for technical personnel to align and calibrate the Series MS240 Monitor Oscilloscope. The alignment should be accomplished at regular periodic intervals to ensure the proper operation of the instrument.

5-3. The alignment and calibration of the Model MS240 is covered in this procedure. The calibration of the Power Supply should always be accomplished prior to the module.

WARNING

When performing the power supply alignment, the instrument may be operating with the top cover removed. High voltages, which could be lethal are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The top cover should be removed only for the duration of time required to make the alignments. The power should be off while the cover is being removed or installed.

5-4. Test Equipment Required

5-5. The following test equipment is required to align and calibrate the instrument. The model number and manufacture may be substituted if the specifications of the substituted units are equal to or better than the listed equipment.

1.	Sine Wave Generator	HP Model 651B
2.	Square Wave Generator	HP Model 211B
3.	Frequency Counter	HP Model 5321B
4.	Oscilloscope	Vu-Data PS910A
5.	DC Voltmeter	Hnywl. Model 500
6.	DC Voltmeter	1.5VDC Battery

5-6. Power Supplies

5-7. After a 30 minute warm-up, turn off the power and remove the Channel 1 oscilloscope module. The voltages from the power supplies can be measured on the connector using the information on pin locations shown above the connector, or reference Figure 3-1. If the voltages need aligning, the top cover will have to be taken off, ALWAYS TURN THE POWER OFF BEFORE REMOVING THE TOP COVER. (See warning following paragraph 5-3.).

5-8. Model MS240 Module

5-9. After the 30 minute warm up has been accomplished, turn off the power and connect the module to be aligned in the module extender and insert the extender into the channel of the module to be measured. Turn on the power and pre-set the controls as shown in Table 5-1. Location of these controls are shown in Figure 5-1.

Vertical Position	Mid-Range
Horizontal Position	Mid-Range
Trace Angle	Mid-Range
Trigger Polarity	+
Focus	Mid-Range
Intensity	CW
Input Mode	GRD
AC/DC	AC
Volt/Div	.05
Msec/Div	1.0
X10 Vernier	CAL

Table 5-1. Control Pre-Adjustments

Control Pre-Adjustment — Adjust the vertical and horizontal position control for a centered sweep. Adjust the focus and intensity controls for a desirable display. Adjust the trace angle control to align the trace with the graticule.

5-10. Module Adjustments

5-11. Using the sine wave generator with a load of 50 ohms (1) Apply a 0.2 volt p-p signal at 1 KHz to the input. (2) Position the Input Mode switch, S1 to the input position.

5-12. A stable 1 KHz sine wave should be displayed on the CRT. If the signal does not trigger properly adjust R50 for a stable display at a point midway between where the display disappears and where the display free runs or becomes unstable.

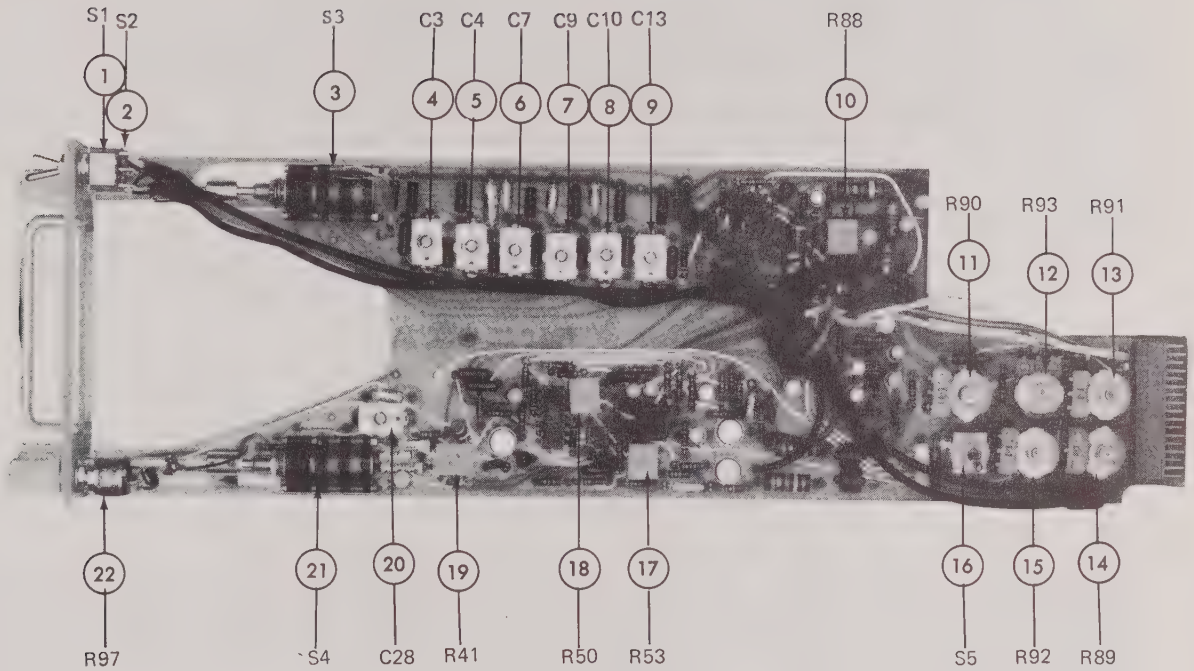
NOTE

A CCW rotation will cause the display to disappear and a CW rotation will cause the display to become unstable.

5-13. Trigger Polarity

5-14. With the trigger switch, S5, located on the rear porch set in the + position, the start of the display should occur during the positive slope of the cycle. Switch the trigger polarity switch to — position and the start of the display should occur during the negative slope of the cycle.

5-15. To check the external trigger position, apply an input from the sine wave generator to the external input connector. Adjust the sine wave generator for an output of 0.5 volts p-p. Set the Volts/Div switch to the .2 position. Set the trigger polarity switch to external. The display should continue to be a stable display of 1 KHz. Return the trigger polarity switch to + position and disconnect the external trigger input. Re-position the Volts/Div switch to the .05 position.



1. INPUT SELECTOR SWITCH
2. AC/DC SWITCH
3. V/DIV SWITCH
4. .1 VOLT COMPENSATION
5. 5 VOLT COMPENSATION
6. 2 VOLT COMPENSATION
7. 1 VOLT COMPENSATION
8. .5 VOLT COMPENSATION
9. .2 VOLT COMPENSATION
10. VERTICAL GAIN CONTROL
11. INTENSITY CONTROL
12. FOCUS CONTROL
13. VERTICAL POSITION CONTROL
14. HORIZONTAL POSITION CONTROL
15. TRACE ANGLE CONTROL
16. TRIGGER POLARITY
17. SWEEP LENGTH
18. SWEEP STABILITY
19. SWEEP CALIBRATION
20. HIGH FREQUENCY ADJUSTMENT
21. MSEC/DIV
22. X10 VERNIER

Figure 5-1. Controls for Model MS240 Monitor Oscilloscope

5-16. Vertical Accuracy

5-17. Set the output from the sine wave generator to 0.2 volt p-p ±1%. The vertical display on the CRT should be 4 divisions ±3%. Vertical gain control, R88, should be adjusted if required.

5-18. Vertical Bandwidth

5-19. Increase the output frequency of the sine-wave generator while holding the output amplitude constant within 3%. The amplitude of the CRT display should be less than 1db down at 5 MHz and less than 3 db down through 10 MHz. The value of capacitor C12 determines the frequency gain and is pre-selected at the factory and therefore should not require changing in the field. If for some reason, it does need to be changed, an increase in capacity will increase the vertical output at high frequencies.

5-20. Attenuator Compensation

5-21. Replace the sinewave generator output, to A input, with the output from the square wave generator. Set the generator for a output voltage of 0.5V P-P at 1 KHz. Set the Volts/Div switch, S3 to the .2 position and adjust the X10 vernier for a display of approximately 2 cycles. The square wave output should be free from abnormal rounding or peaking. Capacitor C13, may be adjusted to square the signal.

5-22. Repeat the process for the remaining steps of the attenuator. The output from the generator should be increased as the attenuation is increased. In the high attenuation positions the 50 ohm load should be removed from the generator to increase the output voltage. The adjustments for each attenuation range are as follows:

Range	Adjustment
0.1V	C3
0.5V	C10
1.0V	C9
2.0V	C7
5.0V	C4

5-23. Vertical Attenuator Accuracy

5-24. Remove the square wave generator and apply the sine wave generator to the A input. Set the generator for an output of 0.2V P-P ±1% at 1 KHz. Switch the Volt/Div switch, S3 to the .05 position. The vertical amplitude of the display should be 4 division ±3% of full scale.

5-25. Repeat the procedure for each of the other attenuator positions using the following inputs for the corresponding positions.

Position	Input
.1	.4V P-P
.2	.8V P-P
.5	2.0V P-P
1.0	4.0V P-P
2.0	8.0V P-P
5.0	20.0V P-P

5-26. For the 2 and 5 volt positions, the vertical amplitude of the display should correspond with the sensitivity as indicated on the switch ±3% of full scale.

5-27. Sweep Length

5-28. Adjust the sine wave generator output for .2V P-P at 1 KHz + 0.5%. Adjust the X10 vernier to the CAL position. The length of the sweep should be 12 to 13 divisions. To determine the length, adjust the horizontal positon control for the sweep to start on the 1st vertical line on the graticule, rotate the horizontal position control CCW until the peak of the last sine wave has moved 3 divisions. The end of the sweep should now be located between the last two vertical lines on the CRT. Potentiometer R53 may be adjusted if required.

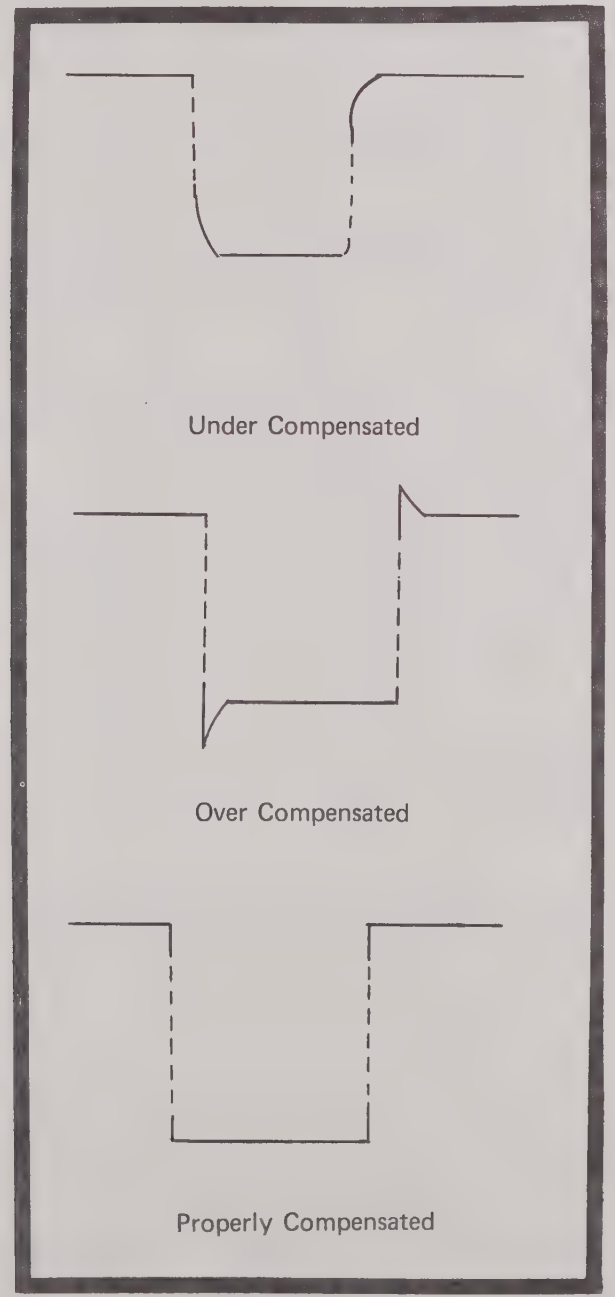


Figure 5-2. Attenuator Compensation

5-29. Sweep Accuracy

5-30. The display on the CRT should be one cycle for each division on the graticule. For ease in observation, the signal should be positioned so the peaks of each cycle are on the center horizontal line of the graticule, (vertical position) and the peak of each cycle on a vertical division line, (horizontal position). The peaks must align with the division graduations within ±3% of full scale (0.3 division). Resistor R41 may be adjusted if required. Check the alignment of the 10msec, .1msec and .01msec positions of the Msec/Div switch, S4, using the input frequencies as shown.

Position	Input Frequency
10msec	100Hz
.1msec	10Khz
.01msec	100KHz

5-31. Control R41 is used for all sweep positions and must be adjusted to minimize the worst case error for all positions.

5-32. Set the sine wave generator for 1 MHz ±0.5% and the Msec/Div switch, S4, to .001 msec. The alignment of the cycles with the division marks should occur within ±3% full scale. Variable capacitor C28 may be adjusted if required.

5-33. TROUBLESHOOTING

5-34. Trouble shooting of the Vu-data, Series MS240 Oscilloscope is not difficult.

5-35. The user of the Series MS240 is urged to familiarize himself with the operation of the instrument before any further trouble shooting is attempted.

WARNING

When trouble shooting the Series MS240 Monitor Oscilloscope, lethal voltages are accessible and extreme caution must be taken.

5-36. The Model MS2002 extender assembly should be used when trouble shooting a module. The extender consists of a printed circuit board which plugs into the position of a defective module. A harness of wires, attached to the PC board, is used to carry the signals and operating voltages to a machined housing which contains a receptacle connector for plugging in the Model MS240 oscilloscope module.

5-37. The bottom cover of the MS2002 is on hinges which in its closed position prohibits the technician from being exposed to the voltages on the bottom of the printed circuit board and also removes the possibility of the circuits being shorted while service or alignment is being performed.

5-38. Figure 5-2 shows the component locations on the module.

NOTE

When replacing components on a printed circuit board, care should be taken to prevent damage to the board from excessive heat or solder bridges. Obvious damage caused by improper techniques will negate the warranty. Soldering irons used should be less than 40 watts.

5-39. Table 5-2. is a DC voltage chart showing the proper levels for all of the transistors and integrated circuits in the Model MS240.

5-40. A sequential trouble shooting procedure, (Paragraph 5-41.) will isolate the problem to an area which should make the repair of the defective assembly relatively easy for the experienced technician. The schematic, Section VI, for the MS240 oscilloscope module, drawing No. 2114020 has wave forms and conditions which are referred to and should be used for ease in trouble shooting.

5-41. TROUBLESHOOTING SEQUENCE

Step 1. Check for proper DC supply voltages using the procedures defined in Section 5

Step 2. Isolate the problem to the power supplies or the modules as follows:

a. The power supplies are common to the Model MS240 modules, therefore, if neither of the modules are operating, the problem is likely in the power supplies.

b. If one of the modules are operating, the problem is in the module not operating.

c. Turn the instrument off and insert an operating module into the position of a defective module. If the module operates, the module previously removed is defective.

d. By using the extender cable, the defective module can be placed in a more advantageous position for detailed trouble shooting.

WARNING

When operating the module in the extender cable, lethal voltages of 2000 volts are present around the CRT and the blanking circuit, consisting of transistors Q9, Q10, Q11, Q12, and Q13.

Step 3. Apply an input signal of 0.2 volts P-P @ 1 KHz to the input connector where the extender cable is installed.

Step 4. Place the input selector switch to the proper input position.

Step 5. Pre-set the controls as shown in Table 5-1.

VERTICAL AMPLIFIER

Step 6. Using an Oscilloscope, measure the input signal on both sides of resistor R14.

NOTE

The schematic figure Vu-data drawing 2114020, shows the proper wave forms and control settings and will be referenced in this procedure.

Step 7. Measure the signal on the collectors of Q1 and Q2. (Reference schematic waveform No. 2) The signal should be the frequency of the input signal and approximately 40.0 volts P-P.

a. If the two signals are unequal or distorted, vary vertical positon control until the signal shown is present.

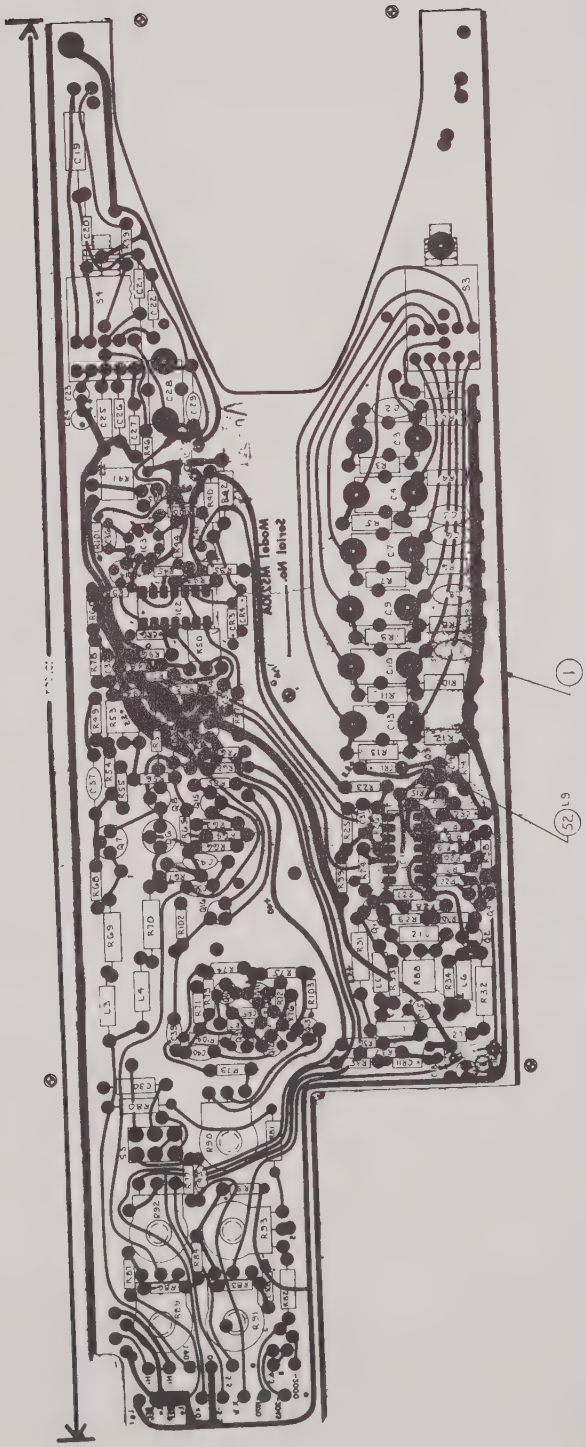


Figure 5-2. Parts Location for MS240

b. This should place the vertical input signal on the face of the CRT.

c. If no signal is present and the waveforms are incorrect, check the waveform at Pin 6 IC1. The signal should be the same (slightly less) as that measured in Step 6. If the signal is less than 75% of Step 6, the problem is likely in the input FET Q3. Change Q3 and Q4 (they must be matched). If that does not cure the problem, IC1 must be changed.

d. If this corrects the problem, recheck Step 7a and adjust for equal undistorted signal. The vertical amplifier portion should be working.

HORIZONTAL AMPLIFIER

Step 8. Using the Oscilloscope, measure the output of IC3, Pin 6. The signal (Reference schematic waveform No. 4) should be a sawtooth of approximately 15 volts peak to peak amplitude.

Step 9. If the signal is not present, module adjustments, for proper alignment of the trigger stability control, variable resistor R50. (Reference Figure 5-2.)

Step 10. If this does not correct the problem measure Pin 1 of IC1 for the same signal. If the signal is not present on Pin 11, IC1. If the signal is present, check switch S5 and capacitor C30.

Step 11. If the signal is correct on Pin 9, IC2 measure Pin 8 of IC2, (Reference schematic waveform No. 10). If the signal is not correct, turn the power off and using an ohmmeter scale R X 100, verify that capacitors C34, C35 and C41 are not shorted. If that does not correct the problem, IC2 is probably bad.

Step 12. If the signal is now proper, recheck Step 9 for proper triggering.

Step 13. Measure the horizontal outputs on the collectors of transistors Q6 and Q7, (Reference schematic waveform No. 1), equal signals should be present by varying the horizontal position potentiometer R89. If they are not, turn the power off and check the continuity of coils L3 and L4.

Step 14. If this does not correct the problem, the problem is either transistor Q6, Q7, Q8 or Q15.

Step 15. If the signals are correct to this point, both the horizontal and vertical circuits are operating properly and the problem is either the CRT or the blanking circuit.

Step 16. Remove the socket from the CRT, (be sure power is removed) and insert a new CRT. Connect the anode of the CRT to ground.

Step 17. Vu-data does not recommend the measuring of the blanking circuit but if a bright spot is present at the start of each sweep or retrace lines are present on the CRT or if no sweep is present and Steps1 through 16 are correct, the problem is probably in the blanking transistors consisting of Q9 through Q13. By changing them in 2 steps, Q9 and Q12 and Q10 and Q11, the unit should be corrected.

5-42. Table 5-3. is a trouble shooting chart which shows the normal symptoms of failure and their remedies.

PROPER DC VOLTAGE LEVELS FOR TRANSISTORS AND INTEGRATED CIRCUITS IN MODEL MS210 OSCILLOSCOPE (Note 1)

WARNING

High voltage assembly 301 must be removed prior to making these measurements.

Conditions:	Input selector switch (rec/Rep) -	Shorted
	Sweep position	1K
	Intensity control	CW
	Vertical position	Centered
	Horizontal position	Centered

Ref. Desi.	Emitter	Base	Collector
Q1	+ 0.5	+ 3.7	+ 17.6
Q2	+ 0.5	+ 3.7	+ 17.6
Q5	- 2.1	- 2.6	- 5.2
Q6	+ 2.8	+ 3.4	+ 31 (Note 2)
Q7	+ 2.8	+ 3.4	+ 164 (Note 2)
Q8	- 3.3	- 2.7	+ 2.8
Q9	- 2.8	- 2.4	- 0.6
Q10	0	- 0.6	- 0.6
Q11	0	- 0.6	+ 38.1
Q12	+ 38.9	+ 38.8	- 0.6
Q13	- 38.4	+ 39.4	+ 39.5
Q15	+ 13.8	+ 14.2	+ 28.5
Q16	+ 4.5	+ 5.1	+ 5.3
	Source	Drain	Gate
Q3	+ 1.8 (Note 3)	+ 5.3	0
Q4	+ 1.8 (Note 3)	+ 5.3	0
Q14	+ 5.25	+ 5.4	+ 5.1

Pins	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC1	+3.8	-0.6	-0.1	+0.7	+2.7	+1.8	+1.1	+3.9	+1.8	+1.1	+3.6	-3.1	-3.9	-0.4
IC2	+5.1	-1.9	-2.3	-1.6	+0.4	+1.1	+0.3	+3.7	+1.7	+1.1	+5.3	-2.7	-3.4	+5.3
IC3	-3.9	+5.3	+5.2	N.C.	+5.5	+2.7	+4.9							

Note 1: Voltages on many circuits can vary depending upon the setting of the controls.

Note 2: Vary horizontal position until collector voltages agree on both Q6 and Q7.

Note 3: Source voltages must be matched to 0.1 volts DC.

Table 5-2. DC Voltage Chart for Semiconductors

SYMPTOM	POSSIBLE MALFUNCTION	REMEDY
1. Blank Screen	Blown Fuse	Change F1
	High voltage switch in off position	Turn display switch on
	Vertical circuit not operating	Check per steps 3 thru 9
	Trigger stability control misadjusted	Check per step 11
	Blanking circuit malfunction	Check per step 17
	Power supplies	Check per step 1 and 2
	Power Off	Turn power on
2. Vertical but no sweep	Horizontal output transistors Q6 and Q7	Check per step 13
	IC3	Check per steps 9 thru 11
	CR10 – anode voltage 26.2 to 29 volts	Replace CR10
	IC1	Check per step 10
	IC2	Check per step 11
3. No horizontal position	Q15	Change Q15
4. Free runs but will not trigger	Trigger not set properly	Check per step 11
	IC2	Change IC2
5. Insufficient vertical position	Leaky or mismatched input FETS	Change Q3 and Q4
6. No intensity control	Q13	Change Q13
7. Bright spot at start of trace	Q9 – Q10, Q11, Q12	Change per step 17
	CRT	Check per step 16
8. Horizontal retrace lines	Q9 – Q10, Q11, Q12	Change per step 17

Table 5-3. Trouble Shooting Chart

SECTION VI

PARTS LIST

Mfg. Code Number	*Manufacturer*	*Location*
00853	Sangamo	Marion, Illinois
01121	Allen Bradley	Milwaukee, Wisconsin
01294	Texas Instruments	Dallas, Texas
04062	Elmenco	New York, New York
04713	Motorola	Phoenix, Arizona
05397	Kemet	Cleveland, Ohio
07263	Fairchild	Mt. View, California
12406	Elpac	Fullerton, California
14099	Semtech Corp.	Newbury Park, California
14752	Electrocube	S. Pasadena, California
15818	Amelco	Mt. View, California
24931	Specialty Connector, Co., Inc.	Indianapolis, Indiana
26533	Zero	Burbank, California
27556	IBM	Santa Fe Springs, California
28520	Heyman Mfg., Co. (Heyco)	Kenilworth, New Jersey
34160	Vu-data Corp.	San Diego, California
44655	Ohmite Mfg., Co.	Skokie, Illinois
56289	Sprague	North Adams, Massachusetts
71450	CTS	Elkhart, Indiana
71590	Centralab	Milwaukee, Wisconsin
76055	Mallory	Frankfort, Indiana
78488	Stackpole	St. Mary's, Pennsylvania
78553	Tinnerman Products	Cleveland, Ohio
80368	Sylvania	New York, New York
81073	Grayhill	La Grange, Illinois
83330	H. H. Smith	Brooklyn, New York
84171	Arco	Great Neck, New York
86684	RCA	Harrison, New Jersey
87034	Marco-Oak	Anaheim, California
88245	Useco	Van Nuys, California
90201	Mallory	Indianapolis, Indiana
91637	Dale	Columbus, Nebraska
91662	Elco	Willow Grove, Pennsylvania
92219	Waldom	Chicago, Illinois
94222	Southco	Chester, Pennsylvania
95566	Arnold Eng.	Orange, California
99800	Delevan Electric Corp.	Aurora, New York

Table 6-1. Manufacturer's Codes

Table 6-2. Parts List (Oscilloscope Module A1)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
R1	RN60D 1005F	1 Mohm, 1%, 1/8W	5-50490	91637
R2	RN60D 1005F	1 Mohm, 1%, 1/8W	5-50490	91637
R3	RN60D 4993F	499 Kohm, 1%, 1/8W	5-50461	91637
R4	RN60D 1002F	10 Kohm, 1%, 1/8W	5-50299	91637
R5	RN60D 1005F	1 Mohm, 1%, 1/8W	5-50490	91637
R6	RN60D 2562F	25.6 Kohm, 1%, 1/8W	5-50338	91637
R7	RN60D 9763F	976 Kohm, 1%, 1/8W	5-50489	91637
R8	RN60D 5232	52.3 Kohm, 1%, 1/8W	5-50368	91637
R9	RN60D 9533F	953 Kohm, 1%, 1/8W	5-50488	91637
R10	RN60D 1103F	110 Kohm, 1%, 1/8W	5-50398	91637
R11	RN60 D9093F	909 Kohm, 1%, 1/8W	5-50486	91637
R12	RN60D 3333F	332 Kohm, 1%, 1/8W	5-50444	91637
R13	RN60D 7503F	750 Kohm, 1%, 1/8W	5-50472	91637
R14	RC07GF104J	100 Kohm, 5%, ¼W	5-10104	01121
R15	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10182	01121
R16	RC07GF222J	2.2 Kohm, 5%, ¼W	5-10222	01121
R17	RC07GF680J	68 ohm, 5% ¼W	5-10680	01121
R18	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10182	01121
R19	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R20	RC07GF122J	1.2 Kohm, 5%, ¼W	5-10122	01121
R21	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10182	01121
R22	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R23	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R24	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R25	RC07GF392J	3.9 Kohm, 5%, ¼W	5-10392	01121
R26	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10182	01121
R27	RC07GF101J	100 ohm, 5%, ¼W	5-10101	01121
R28	RC07GF122J	1.2 Kohm, 5%, ¼W	5-10122	01121
R29	RC07GF101J	100 ohm, 5%, ¼W	5-10101	01121
R30	RC07GF101J	100 ohm, 5%, ¼W	5-10101	01121
R31	RC32G242J	2.4 Kohm, 5%, 1W	5-30242	01121
R32	RC32G242J	2.4 Kohm, 5%, 1W	5-30242	01121
R33	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R34	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R35	RC07GF100J	10 ohm, 5%, ¼W	5-10100	01121
R36	RC07GF100J	10 ohm, 5%, ¼W	5-10100	01121
R37	RC07GF100J	10 ohm, 5%, ¼W	5-10100	01121
R38	RC07GF100J	FSV, 5%, ¼W	5-1	01121
R39	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R40	RN60D 2493F	249 Kohm, 1%, 1/8W	5-50432	91637
R41	360T254B	250 Kohm, Pot.±20%, ¼W	5-73254	71450
R42	RN60D 4993F	499 Kohm, 1%, 1/8W	5-50461	91637
R43	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R44	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R45	RC07GF272J	2.7 Kohm, 5%, ¼W	5-10272	01121
R46	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R47	RC07GF101J	100 ohm, 5%, ¼W	5-10101	01121

Table 6-2. Parts List (Oscilloscope Module A1) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
R48	RC07GF392J	3.9 Kohm, 5%, ¼W	5-10392	01121
R49	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R50	360T501B	500 ohm, Pot.±20%, ¼W	5-73501	71450
R51	RC07GF222J	2.2 Kohm, 5%, ¼W	5-10222	01121
R52	RC07GF102J	1 Kohm, 5%, ¼W	5-10102	01121
R53	360T503B	50 Kohm, Pot. ¼W	5-73503	71450
R54	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R55	RC07GF183J	18 Kohm, 5%, ¼W	5-10183	01121
R56	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R57	RN60D 4120F	412 ohm, 1¼, 1/8W	5-50155	91637
R58	RN60D 5231F	5.23 K, 1%, 1/8W	5-50272	91637
R59	RN60D 5231F	5.23 K, 1%, 1/8W	5-50272	91637
R60	RC07GF681J	680 ohm, 5%, ¼W	5-10681	01121
R61	RC07GF100J	10 ohm, 5%, ¼W	5-10100	01121
R62	RC07GF100J	10 ohm, 5%, ¼W	5-10100	01121
R63	RC07GF183J	18 Kohm, 5%, ¼W	5-10183	01121
R64	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R65	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R66	RC07GF183J	18 Kohm, 5%, ¼W	5-10183	01121
R67	RC07GF564J	560 Kohm, 5%, ¼W	5-10564	01121
R68	RC07GF564J	560 Kohm, 5%, ¼W	5-10564	01121
R69	RC32G393J	39 Kohm, 5%, 1W	5-30393	01121
R70	RC32G393J	39 Kohm, 5%, 1W	5-30393	01121
R71	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R72	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R73	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R74	RC07GF473J	47 Kohm, 5%, ¼W	5-10473	01121
R75	RC07GF473J	47 Kohm, 5%, ¼W	5-10473	01121
R76	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R77	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R78	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10102	01121
R79	RC07GF103J	10 Kohm, 5%, ¼W	5-10103	01121
R80	RC20GF625J	6.2 Mohm, 5%, ½W	5-20625	01121
R81	RC20GF625J	6.2 Mohm, 5%, ½W	5-20625	01121
R82	RC20GF394J	3.9 Mohm, 5%, ½W	5-20395	01121
R83	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R84	RC07GF472J	4.7 Kohm, 5%, ¼W	5-10472	01121
R85	RC07GF682J	6.8 Kohm, 5%, ¼W	5-10682	01121
R86	RC07GF683J	68 Kohm, 5%, ¼W	5-10683	01121
R87	RC07GF333J	33 Kohm, 5%, ¼W	5-10333	01121
R88	360T101B	100 ohm, Pot,20%,1/8W	5-73101	71450
R89	UH4603	50 Kohm, Pot,20%,1/8W	5-74503	71450
R90	UH4603	50 Kohm, Pot,20%,½W	5-74503	71450
R91	UH4602	2 Kohm, Pot, 20% ¼W	5-74202	71450
R92	UH4602	2 Kohm, Pot, 20%, ½W	5-74255	71450
R93	UH4604	2.5 Mohm, Pot,20%,½W	5-74255	01121
R94	RC07GF272J	2.7 Kohm, 5%, ¼W	5-10272	01121

Table 6-2. Parts List (Oscilloscope Module A1) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
R95	RC07GF681J	680 ohm, 5%, ¼W	5-10681	01121
R96	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R97	RV6NAYSD	50 K Pot, 20%	5-75503	01121
R98	RC07GF102J	1 Kohm, 5%, ¼W	5-10102	01121
R99	RC07GF471J	470 ohm, 5%, ¼W	5-10471	01121
R100	RC07GF182J	1.8 Kohm, 5%, ¼W	5-10182	01121
R101	RC07GF101J	100 ohm, 5%, ¼W	5-10101	01121
R102	RC07GF222J	2.2 Kohm, 5%, ¼W	5-10222	01121
R103	RC07GF221J	220 ohm, 5%, ¼W	5-10221	01121
R104	RC07GF221J	220 ohm, 5%, ¼W	5-10221	01121
C1	210B1C104	.1 ufd. Met. Mylar, 200V	6-47104	14752
C2	CM05CD100J03	10 pf, Dipped Mica, 500V	6-19100	00853
C3	PC400	.9 to 7 pf, Variable	6-96000	84171
C4	PC400	.9 to 7 pf, Variable	6-96000	84171
C5	CM06FD511J03	510 pf, 500V Dip Mica	6-19511	56289
C6	CM05CD221303	220 pf, 500V Dip Mica	6-19221	56289
C7	PC400	.9 to 7 pf, Variable	6-96000	84171
C8	CM05FD101J03	100 pf, 500V Dip Mica	6-19101	56289
C9	PC400	.9 to 7 pf, Variable	6-96000	84171
C10	PC400	.9 to 7 pf, Variable	6-96000	84171
C11	CM05FD330J03	33 pf, 500V Dip Mica	6-19330	56289
C12	DD222	.0022 uf, Cer Disc 50V	6-20222	71590
C13	PC400	.9 to 7 pf, Variable	6-96000	84171
C14	DM471	470 pf, Cer. Disc, 50V	6-27471	71590
C15	K4R7E50	4.7 uf, 50V, Tantalum	6-06475	05397
C16	5GA-T12	.0012 ufd, Cer. Disc	6-20122	56289
C17	K47RE6	47 uf/6V, Tantalum	6-71476	05397
C18	K47RE6	47 uf/6V, Tantalum	6-71476	05397
C19*	Matched Set	1 uf, P. Carb., 50V	6-40000	27556
C20*	Matched Set	.1 uf, P. Carb., 50V	6-40000	27556
C21*	Matched Set	.01 uf, P. Carb., 50V	6-40000	27556
C22*	Matched Set	.001 uf., P. Carb., 50V	6-40000	27556
C23	KR47E35	.47 ufd/35V, Tantalum	6-75474	05397
C24	K4R7E35	4.7 ufd/35V, Tantalum	6-75475	05397
C25	ZD2A473	.047 Met.Mylar, 200V	6-47473	27556
C26	ZD4A472	.0047 Met.Mylar,100V	6-47472	27556
C27	5HK-D22	.0022 ufd Cer.Disc 50V	6-20222	
C28	PC402	1.5 to 1.0 pf, Variable	6-96001	84171
C29	CM05FD820J03	82 pf, P.S., 50V	6-66820	56289
C30	ZD2A104	0.1 ufd,Met.Mylar,200V	6-47104	12406
C31	DDM050	5pf,Dip,Mica, 50V	6-19050	56289
C32	DDM050	5pf,Dip,Mics, 50V	6-19050	04062
C33				
C34	K47RE6	47uf/6V, Tantalum	6-71476	05397
C35	K47RE6	47uf/6V, Tant. 6V	6-71476	05397

Table 6-2. Parts List (Oscilloscope Module A1) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
C36	DM151	150 pf, Cer.Disc., 50V	6-27151	71590
C37		FSV, Cer.Disc., 50V		71590
C38	DDM103	.01 uf,50V. Cer. Disc	6-27103	71590
C39	DD30-391J	390pf, 3KV, Cer.Disc	6-29391	71590
C40	DDM103	.01uf, Cer.Disc., 50V	6-27103	71590
C41				
C42	CM05ED330P03	33pf	6-19330	56289
C43	DM471	470 pf, Cer.Disc., 50V	6-27471	71590
Q1	TP290	2N2369 Transistor	3-22369	TP1
Q2	TP290	2N2369 Transistor	3-22369	TP1
Q3	KE4093	Field Effect Transistor	3-21837	15818
Q4	KE4098	Field Effect Transistor	3-21837	15818
Q5	2N4250	2N4250 Transistor	3-24250	07263
Q6	SE7056	SE7056 Transistor	3-27056	07263
Q7	SE7056	SE7056 Transistor	3-27056	07263
Q8	2N3694	2N3694 Transistor	3-23694	07263
Q9	2N3694	2N3694 Transistor	3-23694	07263
Q10	GT2907	GT2907 Transistor	3-22907	GE
Q11	2N3694	2N3694 Transistor	3-23694	07263
Q12	GT2902	GR2902 Transistor	3-22907	GE
Q13	2N3694	2N3694	3-23694	07263
Q14	KE4093	Field Effect Transistor	3-21837	15818
Q15	2N3694	2N3694 Transistor	3-23694	07263
Q16	2N3694	2N3694 Transistor	3-23694	07263
		INTEGRATED CIRCUITS		
IC1	CA3046	CA3046 I.C.	3-33046	18722
IC2	CA3046	CA3046 I.C.	3-33046	18722
IC3	LM301A	LM301A I.C.	3-30301	National
		DIODES		
CR1	IN914	IN914 Diode	3-10914	Jedec
CR2	IN914	IN914 Diode	3-10914	Jedec
CR3	IN914	IN914 Diode	3-10914	Jedec
CR4	IN914	IN914 Diode	3-10914	Jedec
CR5	IN914	IN914 Diode	3-10914	Jedec
CR6	IN914	IN914 Diode	3-10914	Jedec
CR7	IN914	IN914 Diode	3-10914	Jedec
CR8	IN914	IN914 Diode	3-10914	Jedec
CR9	IN914	IN914 Diode	3-10914	Jedec
CR10	IN971	IN971B Diode	3-10971	Jedec

Table 6-2. Parts List (Oscilloscope Module A1) Continued

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	VU-DATA PART NO.	MANUFACTURER
		COILS		
L1	61537-40	15 uh	5-90015	99800
L2	61537-40	15 uh	5-90015	99800
L3	MS290537-61	10 mh	5-90105	99800
L4	MS290537-61	10 mh	5-90105	99800
L5	1537-52	33 mh	5-90033	99800
L6	9330-36	33 mh	5-90033	99800
L7	91217	Trace Angle Coil	5-90000	34160
		SWITCHES		
S1	7211	2 pole, 3 pos. toggle	2-10002	C & K
S2	7101	1 pole, 2 pos. toggle	2-10003	C & K
S3	8YY23340-1-7	PC type, 2P, 7P	2-10000	81073
S4	8P36-02-1-5N	PC type, 2P, 5P	2-10001	81073
S5	7211	2 pole, 3 pos. toggle	2-10002	C & K
		MISCELLANEOUS ITEMS		
V1	3SC4348P31	Cathode Ray Tube, P31	3-40000	80368
	2121001	Shield, CRT	1-10100	95566
J1	7022	Connector	2-27022	91662
J2	3SC4348P	Socket CRT	2-50000	91662
	2121003	Reticule	2-60000	34160
	WA1001A	Knobs (3) Front Panel	4-10000	92219
	RB-67-O-ML	Knobs (5) Porch	4-10001	Rogan
	SC180	Couplers (2)	4-20003	83330
	2121019	Shaft Extenders (2)	NPN	
	2122005	Front Panel	1-10102	34160
	2122002	Rear Porch	1-10101	34160
	2121005	Handle	4-10002	88245
	2132007	PC Board	1-20000	34160

SECTION VII

DRAWINGS

List of Drawings:

Figure 7-1. MS240 Oscilloscope Module

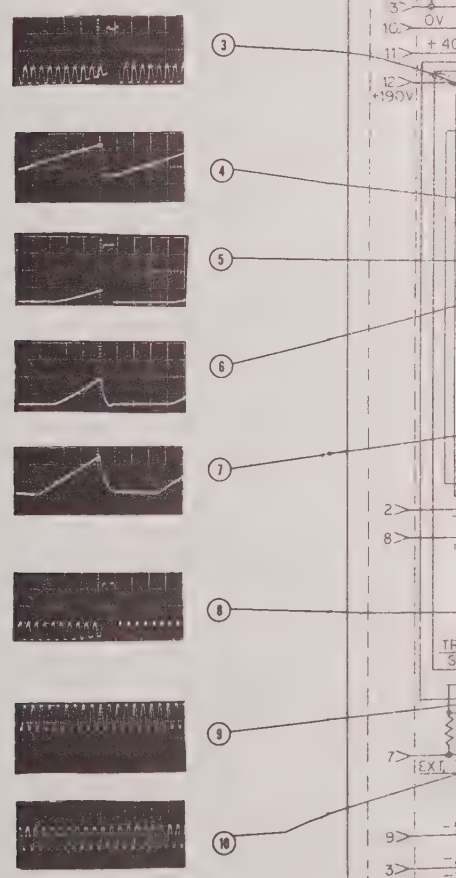
INPUT SIGNAL 1 KC

WAVEFORM CRITERIAS

		Model MS210A				Scope	
#	Location	Volts/In	Freq.	Trigger	Sweep Rate	*0 Volts	Vert. Sens.
1	Collector, Q7	.1	100	+	2 ms/cm	1	2 v/cm
2	Collector, Q1	.1	100	+	2 ms/cm	1	10 v/cm
3	Emitter, Q16	.1	100	+	2 ms/cm	2	2 v/cm
4	IC3, Pin 6	.1	100	+	2 ms/cm	2	10 v/cm
5	IC1, Pin 1	.1	100	+	2 ms/cm	1	2 v/cm
6	IC2, Pin 4	.1	100	+	2 ms/cm	3	1 v/cm
7	IC2, Pin 13	.1	100	+	2 ms/cm	4	1 v/cm
8	IC1, Pin 5	.1	100	+	2 ms/cm	2	2 v/cm
9	IC2, Pin 9	.1	100	+	2 ms/cm	1	.5 v/cm
10	IC2, Pin 8	.1	100	+	2 ms/cm	1	2 v/cm

Trigger on scope should be in External, DC coupled and taken from IC3, Pin 6

* 0 Volts - This number indicates the zero volt position of the waveform #1 indicates the 1st Horizontal line.



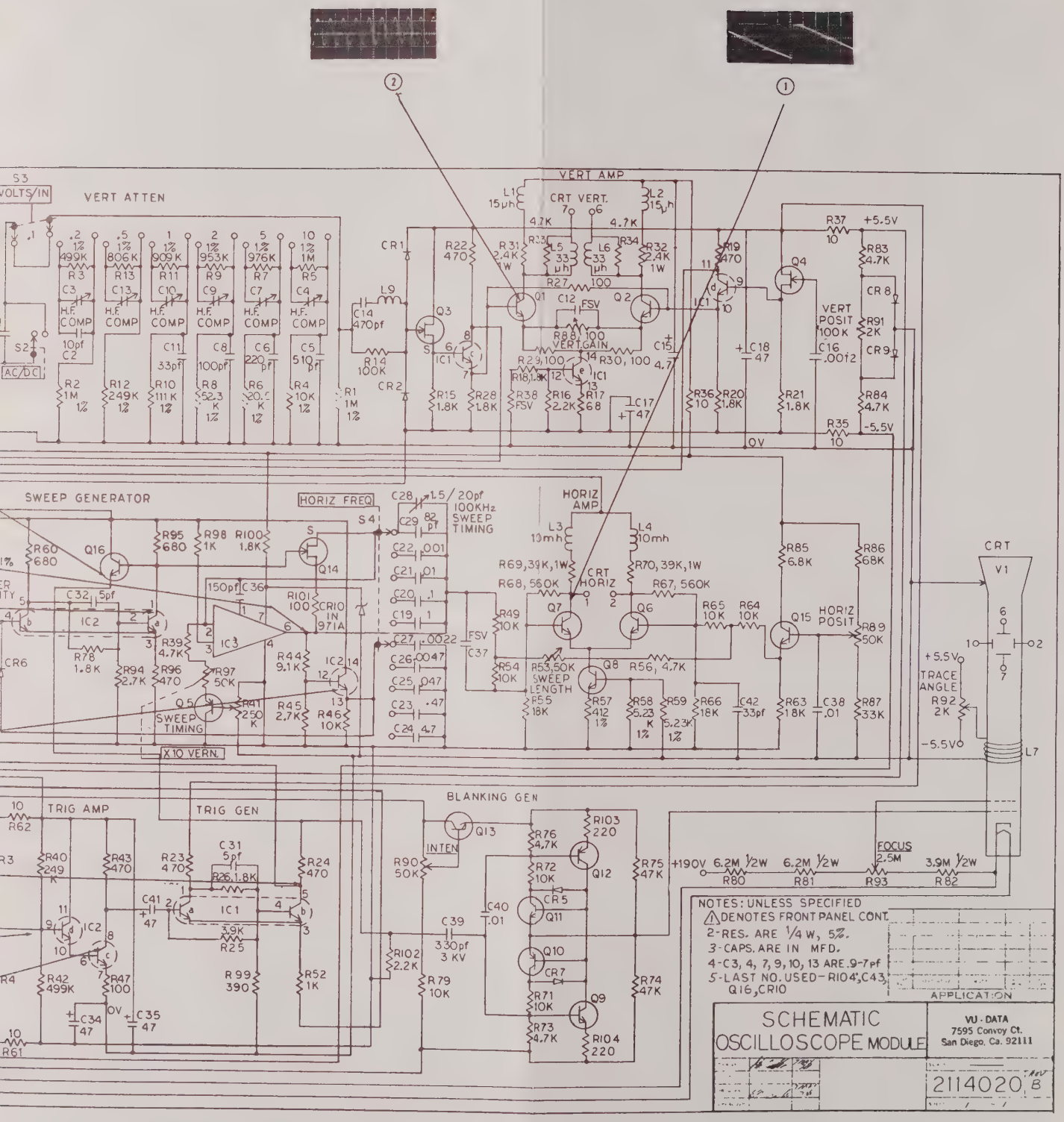


Figure 7-1. MS240 Oscilloscope Module

SECTION VIII

RECOMMENDED SPARES

The following is a list of recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance for one year in an isolated area.

ASSEMBLY OR PART NAME		*PART NUMBER*	*QUANTITY OF PARTS* 1 Inst.	5 Inst.	10 Inst.
Transistor	TP290	3-22369	2	5	5
Transistor	TP289	3-22222	3	6	6
Transistor	TP288	3-22907	3	6	6
FET	U1837E	3-21837	2	5	5
Transistor	SE7056	3-27056	2	5	5
Inte. Circuit	CA3046	3-33046	1	2	4
Inte. Circuit	LM305	3-30305	1	2	4
Inte. Circuit	LM301A	3-30301	1	2	4
Diode	IN914	3-10914	2	5	5
Diode	IN963B	3-10963	1	2	2
	IN985A	3-10984	1	2	2
	IN984A	3-10984	1	2	2
CRT Assembly		3-40000	1	2	4
Fuse 3AG1/4ASB		4-10031	2	4	5

DATA CHECK CORPORATION

LIMITED WARRANTY

DATA CHECK CORPORATION warrants each instrument manufactured by it to be free from defects in material and workmanship under normal use and service for the period of one year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, batteries, or any products or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, Data Check Corporation will repair and calibrate an instrument returned to the factory within one year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the fault has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. *Notify Data Check Corporation, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.*

2. *On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the factory and the instrument returned to you.*

ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS SHALL BE LIMITED TO A PERIOD OF TWELVE MONTHS FROM THE DATE OF PURCHASE. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. DATA CHECK CORPORATION SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

NOTE: Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of Data Check instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be forwarded to Data Check Corporation. Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. Include the model number and serial number when referring to this instrument for any reason.

Data Check Corporation will be happy to answer all application or use questions which will enhance your use of this instrument. Please address your requests or correspondence to:

Attn: Sales Department
DATA CHECK CORPORATION
10070 Willow Creek Road
San Diego, CA 92131